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City, County and State

SEPTEMBER, 1935

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CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

TABLE OF CONTENTS FOR SEPTEMBER, 1935

TIMEWASTERS:

The Relief Workers:

Once upon a time there was a hard-boiled engineer who was in charge of a project employing a number of relief workers. Now these particular relief beneficiaries came from the depths of a large city and they had no inborn desire to earn their bread by the sweating of their brows. Quite the opposite, indeed. But the engineer having a single track mind, and being obsessed with the strange idea that laborers should labor, bore down. As a result, his force was considerably depleted at the end of the first week. One man had found another job and one-fifth of the rest walked out on him. He continued the bearing down process during the second week, with the result that one man was in the hospital (with a toothache) and one-fifth of the remainder quit cold. The third week he lost one man to the CCC, and one-fifth of the rest didn't show up Monday morning. The fourth week, the men having become accustomed to work, 6 of them got other jobs, and one-fifth of the remainder quit. The fifth week, 42 got good jobs with a nearby contractor, and one-fifth of the rest quit. The sixth week, one-fourth of the laborers (as they were now) found other jobs at better pay. During each of the succeeding three weeks the same number found other jobs in private industry, so that at the end of the 9th week, the engineer was on the job totally alone. And the job was done.

The object, of course, of all this is to have our readers tell us how many relief gentlemen were on the job to begin with.

Cork and Coal:

This problem is borrowed (with thanks) from Johns-Manville Co.'s *Power Specialist*, with the kind permission of Mr. Phoenix. It seems that a barge, when laden with full capacity of coal, carries a load of fifty tons. When the coal is replaced with cork, the cargo weighed 15 tons. On one trip it was fully loaded with a mixed cargo of coal and cork, but the coal weighed 5 times as much as the cork. What was the total weight of the cargo?

The Chain Gang:

You have six pieces of chain each four links long. How few links must be cut and welded to join all the pieces into a chain 24 links long?

A Solution:

When a cube is revolved about a diagonal, the volume generated is $1.814a^3$, according to Mr. Bevan. We're willing to take his word for it. We don't know.

W. A. H.

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A. PRESCOTT FOLWELL, *Editor*   **W. A. HARDENBERGH,** *Asso. Editor*

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City, County and State Engineering and Construction

Vol. 66 — *September, 1935* — No. 9

Interesting Features of an Everglades Water Works Plant

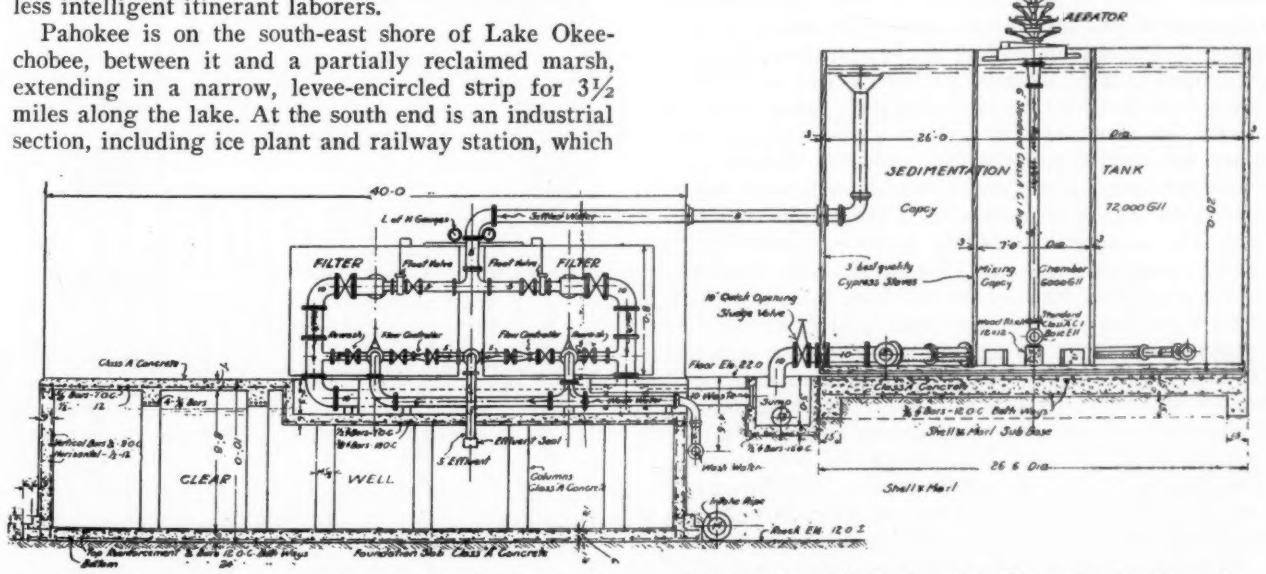
By J. W. Swaren

PAHOKEE, FLORIDA, is now using a new municipally owned water works plant, obtained through PWA funds, having been the first town in the state to begin construction with this Federal aid. Prior to 1930 Pahokee was so insignificant a community as not to appear on the map prepared that year for the National Geographic Society. Now it is the commercial center for the Everglades winter vegetable growing industry, the population reaching 5,000 for three months of the winter, although during the humid heat of summer less than a thousand remain in its shuttered stores and dwellings. Many of the vegetable growers are farmers from all sections of the United States east of the Mississippi river (also Canada and Cuba) who, during the rest of the year, operate farms in these wide-spread localities. When the "picking season" arrives a gay, tatterdemalion army swarms in, penniless; and a few weeks later it leaves in practically the same condition, in spite of piece-work rates that make $10 daily earnings a commonplace.

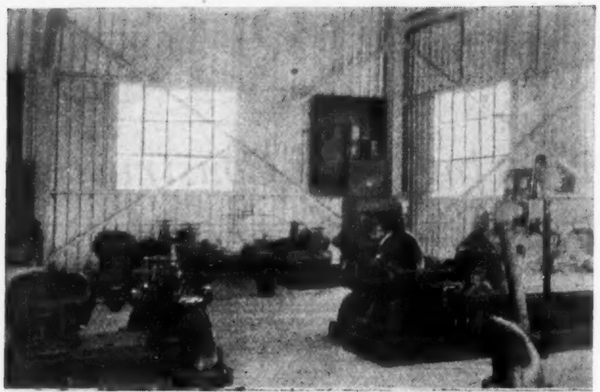
Modern conveniences are desired by the northern-bred farmers, and sanitary measures are realized by them to be necessary not only for their own health but also as a protection against the careless habits of the less intelligent itinerant laborers.

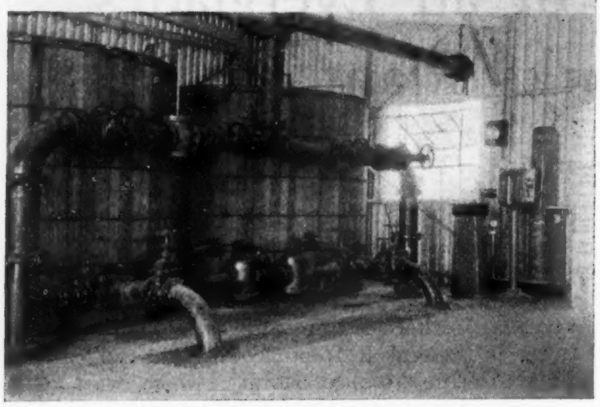
Pahokee is on the south-east shore of Lake Okeechobee, between it and a partially reclaimed marsh, extending in a narrow, levee-encircled strip for 3½ miles along the lake. At the south end is an industrial section, including ice plant and railway station, which is the present southern limit of the water distribution system. For several years the Federal government has been building a levee around the lake (the second largest body of fresh water lying entirely within the United States) to prevent it from flooding the surrounding country during tropical storms; which work (performed by drag lines and suction dredges) will probably be practically completed this year. At Pahokee this levee is to rise to elevation 34.0, or 19 feet above normal lake level, with a water slope of 1:6 and inshore slope of 1:3. The land in the city rises to a maximum elevation of about 25. The lake bottom slopes flatly to a depth of ten feet about a thousand feet from the shore, but a channel is to be dug about 100 ft. out from the foot of the levee, with its bottom carried to elevation —10. This levee had not been constructed at Pahokee when the intake pipe was laid, which facilitated this.

Potable water is a problem throughout the Everglades region. For a great depth, in some places hundreds of feet, the soil consists of decayed and decaying organic matter, and wells give little drinkable water when any at all. Near the lake shore, wells sunk into



Section through pump house and sedimentation tank. Filter wash water and waste pipes laid in channel in floor covered with grating.





Views of Pahokee pump house.

older soils, known as the "custard apple" series, yield small quantities of fairly good water if not drawn upon too heavily; but so many of these would be required for a public supply that it was decided to use lake water for the Pahokee supply. This water, draining from the high lands to the north, is soft, but has a high color and a bitter taste due to tannic acid released by the decaying palmetto. The total turbidity normally approximates 1,000 ppm., and contamination by B coli is commonly found.

The treatment decided on was ammonia applied 40 ft. from the pump suction, followed by chlorine at the suction take-off, while activated carbon and alum are fed into the pump suction. Water so treated is pumped into a mixing chamber, which it enters through an aerator; thence to a sedimentation tank, and from this to gravity rapid sand filters. The filter effluent is discharged directly into a clear water well, from which it is pumped into the distribution system and an elevated tank. The purification and pumping plant have a capacity of about 430,000 gallons a day; with an auxiliary fire service pump with a capacity of 1200 gpm which delivers chloramine-treated but unfiltered water.

Cypress and concrete are used largely in construction. The mixing chamber is a cypress tank 7.0 ft. diameter, and the sedimentation tank, 26 ft. diameter, also is of cypress. Each of the two filter units is a 10 ft. wood stave tank The intake crib is built entirely of cypress piles, sheet piling and wales, with a concrete bottom. All of the station foundation and clear well bottom and walls are concrete. Steel was used for the frame and sides of the pump house, and for the elevated tank and its tower. The station roof is of asbestos. The 14-inch intake pipe was specified to be "Universal" cast-iron pipe or reinforced cement pipe, but the engineers finally adopted "Transite" pipe.

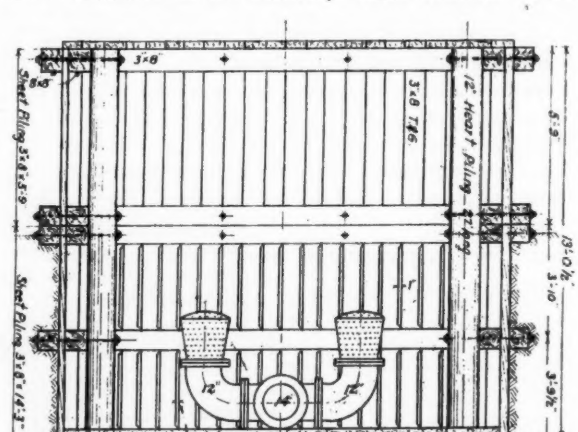
The intake crib is 15 ft. square by 13 ft. deep, of 3" sheet piling sides and deck and a 5-inch concrete bottom which rests on marl and shell; anchored by twelve cypress piles driven to limestone at elevation—7, while the sheet piling was driven to elevation 0.0. On the lake side of the crib is a second row of sheet piling, 15 inches inside the other, the space between the two being filled with ¼" to 2" rock, while 1" openings are left between the sheet piles on this face to admit water. The bottom of the crib is 5 ft. below the general lake bottom, but 17 ft. above the bottom of the navigation channel, which lies 8 ft. beyond the crib.

The intake line begins in the crib with a 14 x 12 x 12 T carrying two 12" elbows set vertical, each with a c.i. strainer. The 393 ft of Transite pipe was laid under the levee (not then built) to the pump house, in a trench 5 to 10 ft. deep.

The clear well, built of concrete 40 by 50 ft. and 8 ft.. 8 in. deep, underlies the entire pump house, the concrete floor of which is supported by the side walls of the well and concrete posts and reinforced beams; the bottom of the well being of concrete on rock at elevation 12. Instead of a regular pipe gallery, trenches or depressions were cast in the pump room floor (and clear well roof) to carry the pipes.

The pump house contains the two filter units, two low-pressure pumps, one service pump, one high-pressure pump, chemical equipment, office and store room. Each raw-water pump is a centrifugal rated at 300 gpm against 35 ft. head; one driven by a 3 hp motor, the other by a 4-cylinder gasoline engine. The "service" pump, which supplies the elevated tank and domestic service is 300 gpm against 137 ft. head, driven by a 15 hp motor. A single-stage 6" turbine pump, 1250 gpm against 100 lb. pressure driven by a 165 hp Sterling engine and drawing either clear well or (in an emergency) raw water, is installed for fire service; it can be cut off from the tank by a valve which is so inter-connected with valves on the raw-water and clear well suctions that raw water cannot enter either the clear well or the tank. All pumps have split casings and bronze impellers and are connected to a vacuum priming pump and tank.

Three plunger-type variable-feed chemical machines feed lime, activated carbon and alum. The treated water is pumped through a 6" c. i. pipe which rises vertically through the center of the mixing chamber and terminates in an aerator, which consists of four



Cross section through intake crib.

tiers of radial troughs, six troughs in each tier, made of 16 gauge galvanized steel; the top tier being 1′ 10″ diameter, the lower ones increasing greater and the bottom one 3′ 6″ diameter. Water overflows from each tier to the next and from the bottom one to a spiral trough which discharges it into the mixing chamber. The mixing chamber and sedimentation tank are two concentric vertical cylinders, the former 7 ft. diameter, the latter 26 ft., and each 20 ft. high, located just outside the pump house. Water flows from the mixing chamber to the sedimentation tank through four 12″ x 24″ openings in the wall of the former; and from the latter into a funnel set 2 ft. below normal water level, and thence into an 8″ pipe which conducts it to the filters. Sludge is drawn from the settling tank through a ring of 8″ and 6″ pipe and eight connected 3″ radial pipe, which rest on the bottom of the tank and are provided with brass orifice strainers.

Flow to the filters is controlled by a float valve. The filters contain 16″ of graded rock and 24″ of high silica sand with 1.6 uniformity coefficient. Each is fitted with a Simplex rate-of-flow controller and loss-of-head gauge. Wash water is taken direct from the mains.

The elevated tank has a capacity of 75,000 gal. The bottom of the bowl is 100 ft. above the ground. The riser pipe is 36″ diameter. The tank and tower are designed to withstand a wind pressure of 150 miles an hour, with the tank empty and the entire pressure carried by one leg; to support which piles for the foundation were driven through the limestone stratum, which is about three feet thick, and penetrating the marl to a depth of 30 ft.

Rafor and Main, of Daytona Beach, were consulting engineers for the city. The writer is greatly indebted to George Main for courtesies and data in the preparation of this article.

Some Bituminous Highway Treatment Costs

SOME interesting data on bituminous highway construction costs are available from the annual report of Mower Co., Minn., A. C. White, highway engineer. Three jobs, totaling somewhat over 29 miles of highways, are covered in detail.

A tar macadam surface was placed on a 10.51-mile strip on PWS job 5754-1, using 600 cubic yards of gravel and crushed stone per mile, which was mixed by a traveling bituminous mixer. The prime coat was of tar, using 0.2 gallon per square yard; the application of tar totaled 0.9 gallon per square yard for a mat 1½ inches thick and 22 feet wide. Costs were as follows:

Aggregate:	
Gravel, 5,390.1 cubic yards @ 10c	$ 539.01
Stripping (team) 1,114.63 c. y. @ 30c	334.39
Stripping (power) 342.04 c. y. @ 15c	51.30
Screening and crushing, 5,390.1 c. y. @ 40c	2,156.04
Loading, 5,390.1 c. y. @ 10c	539.01
Hauling, 50,717.97 yard-miles @ 6c	3,043.08
Bituminous Treatment:	
Road oil No. 1 60/70, 2,820 gals. @ 4.61c	130.00
Tar, TC-1 and TC-2 121,100 gals. @ 9.99c	12,097.89
Bituminous construction 131,810.65 sq. yds. @ 4.53c	5,971.02
Application of oil and tar, 123,920 gals. @ 0.83c	1,028.54
Increase in bituminous construction	1,483.20
Total Cost	$27,373.49
Cost per mile	$2,607.00
Cost per square yard	20.767 cents

The "increase in bituminous construction," due to excess aggregate, amounted to 24.84% of the original estimate under this item. The Klemmer Constr. Co. and Anna G. Nelson furnished the gravel; the Black Top Surfacing Co. carried out the bituminous construction; the road oil was furnished by the Standard Oil Co. and the tar by the Republic Cresoting Co.

Under PWS 5754-2, a cutback asphalt mat 22 feet wide and 1½ inches thick was placed on 11.41 miles of highway. The prime coat consisted of 0.2 gallon per square yard of road oil No. 1 60/70, and 0.7 gallon of cut-back per square yard was used for the wearing course. Mixing was performed with a traveling bituminous mixer.

Aggregate amounts were as follows: Gravel material, 6,078.4 c. y.; stripping, team, 1,256.98 c. y.; stripping power, 385.72 c. y.; screening and crushing, 6,078.4 c. y.; loading, 6,078.4 c. y.; hauling, 73,456.6 yard-miles. The unit costs for each of these operations were the same as for PWS 5754-1.

Bituminous treatment included 36,564 gallons of No. 1 oil at 4.61c per gallon, and 2,354 gallons at 4.37c; 110,025 gallons of cut-back asphalt MC-3 were used at 6.16c per gallon. The application cost was the same as for the other road, 0.83c per gallon; and the cost of bituminous construction was also the same, 4.53c per square yard.

The total cost of this road amounted to $25,123.57, or $2,201.89 per mile. The cost per square yard was 16.66 cents. The contractors were also the same except that the Col-Tex Refining Co. supplied the cut-back asphalt.

PWS 5754-3, 7.86 miles long, was constructed as a cut-back asphalt mat 22 feet wide, and 1½ inches thick, using 550 cubic yards of gravel per mile. The prime was 0.2 gallon of road oil No. 1 60/70, and the wearing course required 0.7 gal. of MC-3 asphalt cut-back. The pavement was surface mixed.

Aggregates included 4,034.9 cubic yards of gravel, and 45,101.54 yard miles of haul. Unit costs for gravel, hauling, team and power stripping, loading and screening and crushing were the same as for the two other jobs described previously.

For bituminous treatment, 29,890 gallons of road oil at 4.61c were used, and 85,861 gallons of cut-back asphalt, MC-3, at 6.16c. Bituminous treatment totaled 105,511.4 square yards, for which the price was 4.53 cents per square yard. Application costs were the same as on the other projects, 0.83c per yard. The total cost was $17,823.12, or $2,267.57 per mile. The cost per square yard was 16.89 cents. The contractors were the same as for the previously described job.

On a 0.7 mile job from LeRoy south to the county line, a tar mat 24 feet wide, using 400 cubic yards of gravel per mile, was constructed. TC-3 was used for both prime and wearing surface. The cost per square yard for this treatment was 10.665 cents.

Creosoted timber bridges also were built under the CWA. The cost to the county on 18 of these bridges, having a total span of 246 feet, was $5,741.84. Most of these had a 20-ft. roadway. Another interesting project in this county was the construction of a stone arch bridge of two 80-foot spans. This was described by Mr. White in the April, 1935, issue of PUBLIC WORKS.

The Probable Flood Flow from a Small Watershed

PROBABLE flood flows must be determined as a preliminary to the designing of spillways to have a capacity sufficient to prevent overtopping and failure of dams. This article brings out some points observed in a study of a watershed which has the following characteristics: Area 1.35 sq. mi.; length 2 miles; slope per 1000 feet, average, 37 feet; topography, rugged and steep, but entirely wooded and generally with considerable underbrush; location, southern New York State.

The factors of importance in estimating flood flows include the probable maximum rainfall in the time of concentration, the runoff factor generally designated as C, and the size and shape of the watershed.

The time of concentration of the watershed is estimated at from 40 to 60 minutes—probably around 52 to 55 minutes. Meyers formula for intensity of rainfall to be expected with a frequency of 100 years east of meridian 100, in the area of the Great Lakes, and in southern New York and New England is $i = \frac{256}{t + 25}$. This formula give 3.93 inches of rainfall for a 40-minute period, and 3.01 for 60 minutes. New York City has records of rainfall of 3.31 inches in 60 minutes, 4.75 inches in 49 minutes, and 4.84 inches in 37 minutes. The absolute maximum is estimated to be 5.1 inches for 40 minutes and 3.75 inches for 60 minutes. Incidentally the recent rainfall in central New York State showed amounts up to 9 inches in 24 hours and nearly 12 inches in 48 hours. On a small watershed, however, the shorter rates should govern flood flows.

The dam under consideration is important, though small, and to protect another dam just below and residences below that, must pass, without overtopping, all water that comes to it. With this necessity in mind, various investigations into existing data have been made.

Concentration time on Strawberry Creek, Calif., as reported by Lee (ASCE,1928) showed for an area of 509 acres, covered with grass, brush and young pine, with moderately steep slopes, a period of 40 minutes. Velocity over the ground surface, on fairly steep slopes, but retarded by leaves and underbrush and by surface irregularities, will probably be around 0.1 to 0.2 feet per second. In the stream itself, velocities may reach 4 to 6 feet per second. On these bases, concentration time for the area under consideration will approximate 1 hour, but may be slightly less.

The coefficient of runoff reported by Lee above was 0.12; Fuertes reported for a small area of clay land covered with short grass, 0.41. Fruhling states runoff from wooded areas is not over 0.20. Imhoff suggests 0.05; Metcalf and Eddy suggest 0.371 for 60 minutes from a totally pervious area, and 0.334 for 45 minutes; Kuichling 0.05 to 0.25 for parks, gardens, lawns, etc. McGee's formula for sandy, very pervious surfaces, gives C = 0.225 for a 60-minute rain. Horner for a 60-minute storm assumes C = .50. Chamier's findings assign C a value of .45 to .55. On the other hand, in the 1913 flood in Ohio, runoff coefficients on the Miami were .76 for 24 hours, and on the Scioto .59 for the same period.

With the formulas for storm water runoff, which perhaps apply especially well in the case of small areas, some interesting but widely varying results are obtained. Figures given below are of slide-rule accuracy.

Using the Burkli-Ziegler formula, $Q = Ci\sqrt[4]{(S/A)}$ with C = .60 and i = 5.1 (the maximum for 40 minutes), Q is 1,232 cubic feet per second. As used, C is large, without doubt. If the average values for wooded areas are used, 0.225, 0.25, or even the Metcalf-Eddy value of 0.371, the total rate will be much lower. For i = 4 and C = 0.30, Q will be but 468. This illustration is fairly typical of the great variations encountered.

Fuller's 1000-year formula, with a special C of 250, gives for 1.35 sq. mi., a flow of about 1000 cu. ft. per second per sq. mi., or 1350 cfs for the entire watershed.

The value by Kuichling's formula for watersheds of small area (some texts state less than 10 sq. miles, and others less than 100 sq. miles) is somewhat less than the values given above. This formula is

$Q = \frac{35000}{M + 32} + 10$, and with M = 1.35, Q = 1065.

Kuichling's formula for the South Atlantic States, $Q = \frac{41.6\ (620 + M)}{M + 24} + 15$ gives 1021 cfs.

McMath's formula, with r = 4 and C = .50 gives just over 1000 cfs. No other formula, except one advanced by Davis and Wilson, gives discharges in excess of 1000 cfs. The Davis and Wilson formula is Q = inches of rainfall in 24 hours $\times$ 200 $\times$ $M^{2/3}$. With a 9-inch rainfall in 24 hours, which is not unknown in the North Atlantic States, the discharge would approximate 2160 cfs, according to this formula. It is true that there have been instances of such flows on small watersheds, but certainly not in accordance with the factors entering into this formula.

The Dickens formula, $Q = C\sqrt[4]{M^3}$, using C = 350 for mountainous country with a rainfall intensity of 6 inches (probably in 24 hours), gives 427 cfs; with proportional increase for 9 inches, the flow would be 640 cfs. Fanning's formula, Q = 200 ($M^{5/6}$), in which M is in sq. kilometers, gives 568 cfs. Murphy's formula which has the same form as Kuichling's, but with different factors, gives a very low rate for small watersheds—in this case approximately 165 cfs.

Fuller further says that 1 square mile will produce in a 1000-year flood, 6.5 as much as a 100-year flood from 100 sq. mi. per unit area. He also states that the runoff for 1 sq. mi. will be 3 times as great as the runoff due to an average rainfall for 24 hours. On the basis of 9 inches of rainfall in 24 hours, the flow from the area investigated would be about 960 cfs, and for a 12-inch rainfall 1250 cfs.

On the basis of these data, it is estimated that spillway provision for at least 1000 cfs should be provided, and that, supplemented with reservoir storage capacity, a maximum flow of 1300 cfs ought to be handled for at least 1 hour.

The Use of Anthracite in Sewage Sludge Beds

By Ralph R. Cleland* and George S. Scott†

THE sewage disposal plant at State College, Pa., treats on the average 550,000 gallons of domestic sewage per day, utilizing the Imhoff tank-trickling filter process. Because of overloaded tanks, the sludge as drawn is incompletely digested and it is necessary to add a coagulent before it can be dewatered on the sludge drying beds. For coagulation, two pounds of sulphate of alumina per cubic yard of sludge is added, following which the sludge drains readily and dries rapidly.

Four drying beds are employed, two of which are open and two of which are covered with glass. The combined area of the open beds is 1,728 square feet; that of the closed beds is 2,256 square feet. One open and one closed bed contain six inches of sand, effective size 0.26 mm and uniformity coefficient 2.00. The other open and closed beds each contains six inches of anthracite, effective size 0.37 and uniformity coefficient 2.89. Underlying the filter media of the four beds are crushed stone layers, graduated in size from one-quarter inch to one inch.

Formerly, a crushed rock sand had been used, but later it was discarded when it was observed to contain much fine material which, when wet, would tend to cement the grains together into hard lumps. The sand used in the experiments described herein was a washed river sand. The crushed anthracite was placed on one open and one closed bed at the suggestion of the Anthracite Institute, the size to be employed being determined by one of the writers. Careful note was made of the moisture content of the sludge from day to day after drawing, the quality of the effluents, the nature of the sludge cake, the analysis of the sludge drawn, the amounts of filter media adhering to the cake when lifted, the packing of the filter on the beds, and such general observations as seemed to be of interest in deciding upon the relative merits of the two filter materials.

*Sanitary Engineer, The Pennsylvania State College.
†Chemical Engineer, Mauch Chunk, Pa.

Sludge drying on the open beds.

Open and closed beds.

Table 1.—Sludge Analyses. Open Beds

Run No.	*pH*	*Sp. Gr.*	*% Solids*	*% Ash (Dry)*	*% Ether Sol.*	*Deg. F.*
1	6.7	1.034	5.4	44.6	3.7	68
2	6.7	1.007	3.1	35.6	4.7	64
3	6.7	1.014	4.3	38.2	5.7	66
4	6.7	1.010	3.2	40.8	3.3	71
5	6.7	1.030	5.3	39.0	5.3	73
6	6.6	1.031	6.5	39.7	4.1	69
7	6.5	1.014	5.0	55.9	4.8	69
8	6.8	1.011	3.0	37.1	11.6	54
9	6.8	1.020	5.0	39.5	5.3	55
10	6.7	1.010	3.9	32.6	10.1	59
11	6.5	1.007	4.0	33.7	7.7	61
12	6.5	1.008	3.6	30.5	6.3	63
13	6.7	1.003	3.7	36.2	5.4	68
Average	6.7	1.015	4.3	38.7	6.0	65

Table 2.—Drying Rates

	Open Beds			Covered Beds		
Days from Start	*Number of Tests*	*% Moisture in Sludge Anthracite*	*Sand*	*Number of Tests*	*% Moisture in Sludge Anthracite*	*Sand*
0	10	95.4	95.4	10	95.5	95.5
1	5	86.0	86.6	5	86.6	86.8
2	5	83.7	85.4	5	84.9	85.2
3	4	82.8	82.9	1	84.5	84.3
4	3	78.3	80.1	4	85.4	83.8
5	1	76.5	78.4	2	85.0	84.4
6	2	76.9	77.6	1	74.1	80.5
7	4	79.4	80.0	6	82.5	81.2
8	3	78.2	78.9	1	79.0	79.9
9	1	71.2	66.4	2	82.6	79.8
10	4	75.0	74.1	3	80.0	79.1

Table 3.—Effluent Analyses. Open Beds

	Total Solids		*B.O.D.*		*Total Count*		*Anaerobic Count*		*Acid Count*	
Run No.	*Anth. ppm*	*Sand ppm*	*Anth. ppm*	*Sand ppm*	*Anth. per cc*	*Sand per cc*	*Anth. per cc*	*Sand per cc*	*Anth. per cc*	*Sand per cc*
1	1313	1943	46.0	22.0	380,000	90,000	450,000	60,000	....	....
2	1990	2350	119.5	53.2	580,000	188,000	205,000	145,000	14,000	12,000
	2225	2581								
3	1420	1625	78.5	50.2	18,000	20,000	....	....	6,000	10,500
	1805	1770								
4	2056	2992	39.2	57.0	116,000	135,000	171,000	188,000	23,500	41,500
	1601	1475								
5	1085	1670	25.5	10.0	750,000	202,000	2,200,000	820,000	43,000	28,000
	1130	1178								
6	854	1358	15.5	22.9	590,000	270,000	1,140,000	350,000	9,000	5,500
	850	954								
7	1135	1485	....	....	830,000	390,000	180,000	45,000	3,500	5,000
	1350	1500								
8	1930	2645	....	....	280,000	92,000	60,000	84,000	....	....
Average	1482	1823	54.0	35.9	443,000	173,000	629,000	242,000	16,500	17,000

Table 1 shows a summary of the sludge analyses. It is evident from this table that digestion has not been complete, and that difficulties were to be expected in dewatering. It was thought at first that anthracite, due to its larger size, would give more rapid draining or would permit draining with a smaller alum dosage. It was found, however, that the minimum dosage of alum for both anthracite and sand beds was the same—two pounds per cubic yard. When this amount of alum was added there was little difference in drainage between the sand beds and the anthracite beds, as may be seen from table 2. Since these moisture determinations were obtained from different sludge drawings and under various weather conditions, there is not a gradual decrease in the moisture content as might have been obtained by making successive determinations on the same drawing.

As the cost of material is of great importance, and in most cases determines what material shall be used as a medium, it is of value to note comparative costs. As anthracite weighs only about 55 pounds per cubic foot as against about 100 pounds per cubic foot for the average prepared sand, it is at once evident that a ton of anthracite will do the work of almost two tons of sand. This means a saving in freight as well as a saving in original cost.

It was noted that the loss of filter medium by adherence to the dried sludge was identical on a volume basis for the two media. It was also observed that the coal did not pack as much as the sand when tramped on by the workmen lifting the sludge.

Where it is advantageous to burn the sludge, the adhering anthracite would be a direct advantage. It was noted from one case when the sludge was fired that the sludge from the anthracite bed supported its own combustion while the sludge from the sand bed did not.

Prof. D. E. Haley of the Pennsylvania State College has found that vegetables grow more luxuriantly in a soil treated with partially burned fine anthracite than in the same soil without such treatment. This would seem to indicate that sludge dewatered on fine anthracite would suffer no decrease in fertilizer value.

Table 3 shows a summary of the effluent analyses from each of the open beds. Under "total solids," where two figures appear for the same run, they represent determinations at different times on the same day. With the exception of the total solids determination, the effluents from the sand appear to be better than the effluents from the anthracite. This is attributed entirely to the coarser size of the coal. The apparent discrepancy in the case of the total solids is tentatively attributed to the differences in density of the sand and coal dust produced by the sludge lifting process. Although equal volumes of dust would be produced by both media, that from the sand beds would be more dense and hence cause the liquid effluent to contain more solid material on a weight basis.

Interesting Work Relief Projects

Boston, Massachusetts, removed abandoned derelict automobiles from dumps and along highways; Buffalo, New York, is constructing combination roller and ice skating rinks suitable for summer and winter use on idle city-owned lots, the cost being estimated at $620 a unit; federal departments concerned with mapping are sponsoring a work-relief project for mapping the metropolitan areas of Denver, Minneapolis, St. Paul, Cleveland, Detroit, and Pittsburgh.—*Public Management.*

Detailed Costs of Rhode Island Surface Treatment

Costs on an 18-foot surface-treated gravel road near Coventry, R. I., are given in a recent report of the State Board of Public Roads. The length of this road was 3.21 miles, and the area of the pavement 34,300 sq. yds. The contract was awarded to the Lawrence Constr. Co., Providence. Work began April 13, 1934, and was completed Oct. 5, 1934. Costs are as follows:

Grading:		
Clearing and grubbing, 8.5 acres @ $100.00	$ 850.00	
Cutting-removing trees, 5 each @ $15.00	75.00	
Earth excavation, 18,850 cu. yds. @ $0.50	9,425.00	
Ledge excavation, 1,676 cu. yds. @ $1.50	2,514.00	
Borrow outside location, 4,077 cu. yds. @ $0.30	1,223.10	
Trimming and fine grading, 69,670 sq. yds. @ $0.03	2,090.10	
Miscellaneous labor	55.03	
		$16,232.23
Drainage and Foundations:		
Trench excavation (0'-5') 669 cu. yds. @ $0.50	$ 334.50	
Trench ledge (0'-5') 2 cu. yds. @ $2.25	4.50	
Furnish and lay 12" V. C. pipe, 475 lin. ft. @ $1.00	475.00	
Furnish and lay 12" A. C. C. M. pipe, 916 lin. ft @ $1.60	1,465.60	
Furnish and lay 18" A. C. C. M. pipe, 164 lin. ft @ $2.25	369.00	
Furnish and lay 24" A. C. C. M. pipe, 96 lin. ft. @ $3.50	336.00	
Furnish and lay 36" A. C. C. M. pipe, 86 lin. ft. @ $7.00	602.00	
Catch basins (type D) complete, 3 each @ $80.00	240.00	
Drop inlets complete, 4 each @ $60.00	240.00	
Concrete masonry, 24.4 cu. yds. @ $20.00	488.00	
Cobble gutter (grouted), 8 sq. yds. @ $2.00	16.00	
Rip-rap, 342 sq. yds. @ $1.50	513.00	
		$5,083.60
Metalled Surface:		
Gravel base, 9,222 cu. yds. @ $0.60	$5,533.20	
Gravel top, 2,908 cu. yds. @ $1.70	4,943.60	
Refined tar, 30,146 gals. @ $0.15	4,521.90	
		$14,998.70
Structures:		
Wooden guard rail (N) 4,265 lin. ft. @ $0.50	$2,132.50	
Concrete or stone edging, 474 lin. ft. @ $0.40	189.60	
		$2,322.10
Engineering: Resident engineer and inspectors		1,006.65
Advertising		235.90
		$39,879.18

Handling Dirt at Grand Coulee

At Grand Coulee, Washington, approximately 12,000,000 cubic yards of earth from the excavations for the Grand Coulee Dam are being handled at the rate of 3,000 cubic yards an hour.

Excavation dirt is carried on Jeffrey conveyors from the dam excavation to Rattlesnake Gulch, a mile and a quarter away. A period of about 12 minutes is required for the operations from mountainside to stream shovel, to caterpillar truck, to feeder, to belt, to Rattlesnake dump. Seven large heavy duty feeders, a self-propelled distributing stacker and 2 miles of 60-inch wide belt conveyors, making up the largest conveyor system ever used on a construction job, accomplish the task of disposing of the excavated dirt and the filling of the huge cofferdams.

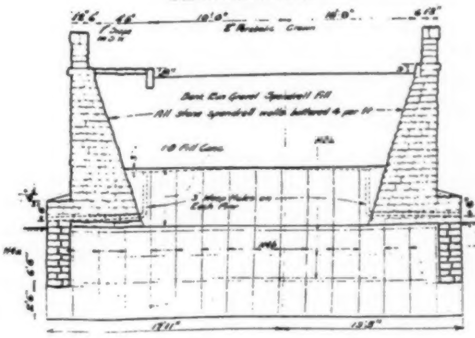
This Armco multi-plate and stone arch bridge was built by force account under direction of the Ohio Department of Highways. It spans Shawnee Creek at the Soldiers and Sailors Orphans Home, Xenia. Spans 10-18-10 feet; 20-ft. roadway plus one 5-ft. sidewalk.

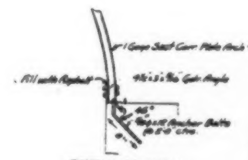
Details of a Beautiful Stone Arch Bridge

ESTIMATED QUANTITIES

Excavation	350 cu. yds.
Conc. 1-6½ (Abut.)	60.8 cu. yds.
Conc. 1-6½ (Pier)	29.5 cu. yds.
Conc. 1-6½ (Abut. Walls)	35.9 cu. yds.
Conc. 1-6½ (Pier Walls)	39.2 cu. yds.
Conc. 1-8 (Fill)	28.6 cu. yds.
Stone Walls	170 cu. yds.
Reinf. Steel	1680 lbs.
7 Plate, Corr. Arch	27.5 lin. ft.
4 Plate, Corr. Arch	55.0 lin. ft.
4½" x 3" x 5/16" Gal. Angles	167 lin. ft.
Spandrell Fill (Bank Run Gravel)	470 cu. yds.

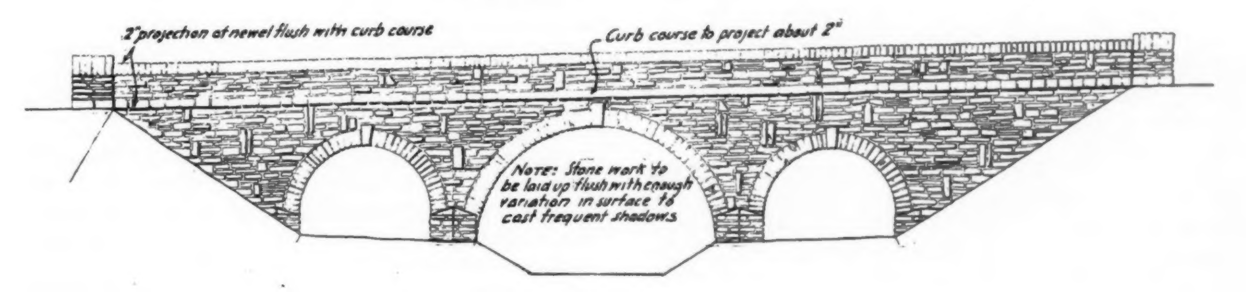
SECTION A-A





DETAIL OF ARCH ANCHORAGE

STEEL LIST					
Mark	Size	Shape	No.	Length	Weight
H4a	[illegible]	Str.	24	6'-6"	163
H4b	[illegible]	"	36	11'-0"	413
H4c	[illegible]	"	24	8'-0"	200
H4d	[illegible]	"	36	10'-0"	376
H2a	[illegible]	"	24	27'-6"	440
Anchor Bolts	[illegible]	Bent	64	1'-0"	88
Total					1680



LONGITUDINAL SECTION

ELEVATION

Aeration of Water by Air Diffusion*

By Frank C. Roe
Sanitary Engineer, The Carborundum Co.

EIGHT water works plants are known to be using the diffused air method of water aeration, and four more to have such aerating units under construction. Those now in service are Brownsville and Victoria, Texas; Huntingburg and Petersburg, Ind.; Ft. Atkinson, Wis.; and Carlinville and Winchester, Ill., all using porous plates; and St. Paul, Minn., using perforated pipe. Under construction are plants at Ontario, Ore., Reading, Pa., Crown Point, Ind., and Ft. Howard Paper Co., Green Bay, Wis.

Air diffusion is employed by each of these for one or more of four purposes: Release and reduction of carbon dioxide and other entrained gases; reduction or removal of odor and taste; oxidation of dissolved iron; and mixing of chemicals. Where there are two purposes, mixing of chemicals is likely to be one of them.

An aeration period of 15 minutes is normally adequate to accomplish any of these purposes. Iron is precipitated in a shorter time, but for release of entrained gases and for mixing, less than 10 minutes is not recommended, but more than 20 minutes probably is unnecessary.

Diffused aeration will generally remove more than 75% of a high carbon dioxide content, and hydrogen sulphide even more completely. It removes odor, especially that caused by aromatic oils, and improves taste in many cases; but water having very strong tastes and odors should receive chlorine or other treatment.

It will quickly and thoroughly convert the iron and manganese content to the insoluble form for subsequent easy removal.

Mixing of chemicals by air diffusion is positive and thorough. The velocity of the water in its flow across the bottom of the aeration chamber in its spiral motion prevents deposit of sediment or floc, but the agitation is not sufficient to break up the floc. There are no unagitated dead spots.

The degree of aeration or mixing can easily be varied at will by varying the amount of air. Practically no head of water is lost in passing through the tank. Installation and operation costs are comparatively low. The power required in four plants for which data were obtained varied from 0.48 kw. per mgd. capacity for gas removal and mixing at Brownsville, using 0.07 cu. ft. of air per gallon with 14 min. aeration, to 1.87 kw. at Ft. Atkinson for iron and odor removal, using 0.16 cu. ft. of air with 18 min. aeration. St. Paul uses only 0.005 cu. ft. of air for odor removal and mixing.

The structures and equipment required are simple. A common and economical arrangement is the introduction of air from blowers through standard-size diffuser tubes suspended in a tank of spiral flow design. In some cases, diffuser plates in the bottom of an aeration tank or in channels are considered more practical and economical.

Of the installations in service, Petersburg uses a tank with an approximately square cross section and suspended diffuser tubes. Brownsville uses diffuser tubes at about mid-depth between the side wall of the tank and a vertical baffle parallel to and a few inches

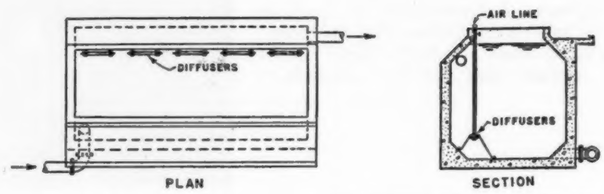


FIG 1. PETERSBURG, INDIANA. WATER PURIFICATION—AERATION AND MIXING

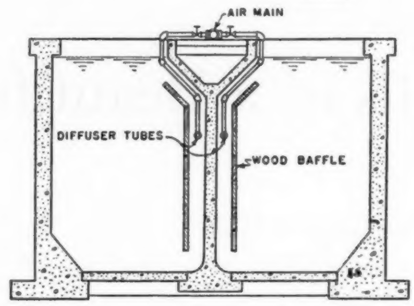


FIG. 2. CROSS-SECTION OF BROWNSVILLE UNIT ELEVATED DIFFUSERS

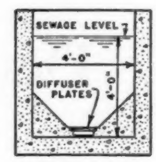


FIG. 3. TYPICAL DIFFUSER INSTALLATION IN CHANNEL

from it. (This has been patented by H. E. Elrod and is the aerator-mixed offered by the Link-Belt Co.) The unit designed for Ontario is a three-pass "around the end" baffled type, each of the three narrow channels having a continuous row of diffuser plates in the bottom. In plants of 2 mgd. or less the square cross section probably is best adapted to securing desirable length. For larger plants, wide tanks are more economical in construction cost. For depth, less than 9 ft. is not recommended and more than 15 ft. gives increased power cost without apparent advantage. Since diffusion through porous mediums eliminates short circuiting, distribution baffles are unnecessary unless extremely high velocities exist.

The plain tank with tubes near the bottom (Petersburg) is simpler than the Brownsville type, and though it requires higher operating pressures, the lower cost of construction may more than offset the higher operating costs under conditions of low power cost and certain types of blowers.

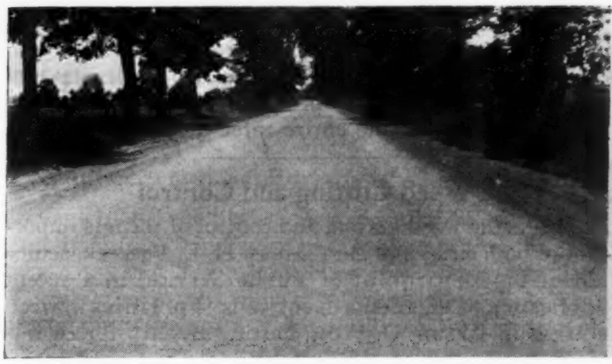
The adequate practice where tubes are used is a single row of tubes from end to end of the tanks, installed in units each of two tubes fed by a single air pipe and held in a special assembly frame of corrosion-resisting material, as developed by the Link-Belt Company. These units can be removed one at a time for servicing while the tank remains in operation.

The type of diffuser plates or tubes usually employed in activated sludge treatment are suitable for aerating water. A medium-high grade of 35 to 40 permeability is recommended. These have low pressure loss, resist clogging, and discharge bubbles not noticeably larger than those from finer-grade diffusers.

Data for the plants in service indicate that the average air requirement is about 0.07 cu. ft. per gal. of water aerated, which would require air blower capacity of 50 cu. ft. per min. per mgd. Centrifugal or positive displacement type blowers are recommended.

The total cost of equipment, installed, is normally less than $500 for a one mgd. unit, and obviously increases less rapidly than the capacity.

*Slightly condensed from a paper before the Illinois Section, American Water Works Ass'n.



Typical calcium chloride stabilized surface at the left. This will provide an ideal base for a tar retread to be applied this fall. The road at the right has received a skin treatment and is now in its third year of service

Stabilized Gravel as Base Course for Bituminous Surfacing

By Jule Huber and Melvin Dick
Maintenance Division, Washtenaw County Road Commission

THAT a thoroughly compacted calcium chloride stabilized gravel wearing course provides an ideal base for bituminous surface is indicated by the experience of the Washtenaw county road commission with a five mile section of road improved by this method. Given a thin bituminous skin treatment two years ago, after having been maintained as a stabilized gravel surface for one year, this road has shown remarkable wearing qualities and has required very little patching.

The section of road improved by this method is a five mile stretch on Huron River Drive. This road is a popular river drive leading from the city of Ann Arbor to the Huron River park, and while it carries very little truck traffic, it is subjected to heavy touring car traffic during the summer months. Traffic on this road averages about 1,500 vehicles a day in summer.

Improvement of this road to its present stage began in 1932 when the ordinary gravel surface was converted into a well-bound, closed surface by the stabilization method. This was one of the first gravel roads to be stabilized in this county, and the stabilization method differed from the procedure we are now following in that calcium chloride was not used integrally in the mixture and the materials used were wet mixed. The resultant highly compacted wearing course, however, was comparable in most respects to the stabilized mats we are now building.

At the time stabilization was undertaken, the surface consisted of an ordinary gravel wearing course about three inches deep. In stabilizing, no new gravel was added, but an analysis of the existing gravel showed that it was lacking in fines. Enough sand was therefore added to bring the mixture to the proper gradation called for by the stabilization specifications, and clay was supplied at the rate of 230 cubic yards per mile. The clay was hauled to the road and placed in windrows where it was allowed to dry. It was then pulverized by disking, and the surface of the road was scarified to a depth of three inches. Following a heavy rain, the scarified gravel, sand and clay were thoroughly mixed by blading back and forth across the roadway. The mixed material was then windrowed to the sides of the road and subsequently was spread over the surface in thin layers and shaped by the blade. It was then permitted to compact under traffic. Calcium chloride was applied to the surface of the road after shaping, and the roadway was maintained throughout the remainder of the summer by occasional light applications of calcium chloride and infrequent bladings after heavy rains. The surface became densely compacted under the heavy traffic and was easy to maintain.

In 1933 it was decided to apply a light bituminous treatment to this road to close the surface and make it permanently dustless. Accordingly calcium chloride was not applied in the spring and by the time we were ready to apply the oil-mix in July, a small amount of loose float material had developed on the surface. This loose cover was less than one-half inch deep and consisted mostly of pebbles about three-eighths to one-quarter inch in size. Although this was a small amount of material to work, no new gravel was used for the bituminous skin treatment.

In applying the oil-mix, an applicaion of No. 6 road oil at the rate of one-fourth gallon per square yard was first made to the surface of the road. Sharp, coarse sand was then spread on the road, at the rate of about 10 to 15 lbs. per square yard, using enough sand to blot up the excess oil. This allowed complete penetration and took care of the excess oil not absorbed into the road. The surface was then given another ¼ gallon treatment of the same oil and again blotted with coarse sand. A broom drag and a truck scraper were used to work this material until it was thoroughly mixed. It was then spread evenly over the road and allowed to pack under traffic, and for the next week or so, places that appeared "fat" were covered with sand until the bleeding condition was corrected. No seal coat was applied until the following year.

Although the resulting bituminous coat was less than one-half inch deep, the road presented an excellent surface. The thoroughly compacted stabilized gravel mat appears to have supplied the necessary strength to resist the weight of traffic. Examination of the road showed that there was a good penetration of oil and the stabilized section, in fact, showed less tendency to peel than did an adjacent section where the same treatment had been applied to a surface on which a light oil dust treatment had been used for several years.

In 1934 the road was given a seal coating with a light application of oil and fine sand but very little patching was required. The road remained in excellent condition throughout the summer. In 1935, after almost two years of service, the expense for patching on the nine miles from the city to the park, including the five miles having the stabilized base, has been only $24.85 for the first five months. This includes the period during which spring repairs were made to the road, and the surface is now in good condition.

The total cost of constructing this road over the three year period has been approximately $1,500 per mile, or about the cost of our ordinary light oil dust treatments (which average about $500 a year) for a three year period. This figure includes the cost of stabilization, the original oil-mix treatment, and the seal coat applied in 1934. Stabilization of this road cost about $600 a mile. The cost of the thin oil-mat was approximately $500 a mile and the seal coat applied in 1934 cost approximately $400. With this expenditure of $1,500 we have a dustless road of good riding quality, and we believe the preliminary construction of the stabilized base has been a good investment.

While there is no other road in the county with exactly the same type of surface on an unstabilized base to which this road can be compared, a comparison can be made with a road which was given a one and one-half inch oil-gravel mix surfacing in 1931 and 1932. This road carries approximately the same number of vehicles per day as Huron River Drive but an allowance must be made for the fact that it does not carry truck traffic, to which the drive is not subject. Patching costs on this second road for the first five months of 1935 on an 11 mile section totaled $337.25, compared to the $24.85 expended on the nine miles of Huron River Drive. The failures in this second road we believe are undoubtedly due in a large part to inadequate base.

The experience with these two roads, therefore, indicates that the cost of the stabilized wearing course to be used as a base course for bituminous treatment is more than repaid by the savings in maintenance costs after the bituminous surface has been applied. During the past two years, Washtenaw county has built twenty additional miles of stabilized gravel surfaces. Six miles of this stabilized surface will be covered this year with a one and one-half inch tar retread. This road is in excellent condition, having a densely compacted mat which will supply an ideal base for the bituminous surface. As this road has practically no loose cover whatever, new gravel will be supplied for the tar treatment to be placed on top of the stabilized course.

In constructing stabilized mats this year, we have adopted the practice of including calcium chloride in the mixture. We find that this method increases the ease of handling the mixture, greatly accelerates the rate of compaction, and probably supplies a greater density throughout the entire three-inch depth of mat.

Backfilling with Tractor and Snow Plow

Weed Cutting and Control

This is the weed season, and control of them is important in both cities and rural areas. H. L. Peacock, senior aid of the Department of Public Service, in a recent publication of that department, tells of practices in weed cutting in Akron, O. Weed cutting by city forces was restricted to lots on which complaints had been registered. Notices were served and many of the lots were cleared by owners; on those not cleared, city forces did the work.

In general, costs to the city are greater, and the Department recommends and urges that owners do their own work. Many amusing events occurred in connection with the work, the city forces being asked to trim hedges, loan scythes, chop down dead trees, etc. Public reaction was generally excellent.

In many cities, rank growths of grass and weeds offer a real problem through grass-fires. These fires frequently occur at points difficult to reach with fire control apparatus. Los Angeles, Calif., uses three Cletrac tractors, two of which carry firefighting equipment. These can traverse even very rough country and steep hills and thus reach the fire without delay. These same tractors and another one equipped with a bulldozer are also used to improve rough roads leading to areas likely to have fires.

It would also seem that such equipment would be very valuable in localizing fires by using the bulldozer to ditch a fire break across the path of the flames.

Mowing with modern mowers is probably the cheapest way to handle grass and weed growths along highways in rural areas, but control by means of chemicals is also possible, and sometimes most economical. There are several weed-killers on the market. The Editor will be glad to send data on these on request.

Milk-Borne Epidemics in 1934

Unpasteurized milk continues to be the source of numerous epidemics of disease, according to a report on milk-borne epidemics in the United States for the year 1934, made by Dr. S. J. Crumbine, Field Secretary of the Conference of State and Provincial Health Authorities of North America, and released by the American Child Health Association in its Bulletin for July.

The report shows 40 epidemics, 1,324 cases and 44 deaths as having occurred in 1934 in 18 states of the Union. Twenty-one of the epidemics were of typhoid fever and 9 of septic sore throat, while gastro-enteritis (4), scarlet fever (3), undulant fever (2), and diphtheria (1) made up the balance.

All but one of the epidemics were caused by raw milk, and in the single exception there is a doubt as to whether the whole of the milk supply was pasteurized.

Backfilling With Tractor and Snow Plow

A novel and efficient method of backfilling water main trenches is shown. A bulldozer, consisting of a Model B, FWD truck equipped with an 8½-foot, straight blade snow plow, fills the trench in record time. The four driving wheels and wide plow of this unit enable it to backfill fast and clean. Its short wheelbase gives it the mobility necessary for speedy work in crowded quarters.

The Editor's Page

Engineers and Sanitarians in Health Work

Some of the medical men in health work seem to be greatly agitated and worried over the position the sanitary engineer has attained in that important field. Knowing personally some of the doctors who have been outstanding in health work, such as Dr. Dowling of Birmingham, we hesitate to express our feelings adequately on the subject. Yet it is a fact that these men of the medical profession who are outstanding in health work have been foremost to utilize the services of engineers; they are wise enough to realize the value of the peculiar training which the engineer has and the medically trained man lacks.

The fiction that no one else can administer the operation of a health department is particularly dear to the hearts of a certain type of medically trained men. Such men chronically see red when an able sanitarian or engineer assumes a position with greater authority or greater compensation than they. Beaureaucratically they then seek to raise the issue of training, and to shut out all who are not of their caste.

But health work is not to any appreciable extent a matter of diagnosing and curing individual cases of disease; its most important function is the providing of physical conditions which will prevent the incidence or spread of disease in communities. The glory of ascertaining the relation of the mosquito to malaria and yellow fever goes to physicians; but the successful steps taken toward elimination of mosquitoes and the continuing fight to that end have been wholly engineering and not at all medical. This is but one illustration; the same principle applies to sewerage, street cleaning and garbage disposal—municipal services which physicians claimed, a few years ago (and perhaps some do still), should be entirely under their control and supervision. Not until engineers took control of these services was appreciable progress made in improving results or introducing economies therein.

Medical training, therefore, is not a very important item in the equipment of a health officer. Much more important is training in adjustment of physical environment to promote healthful conditions. Most important of all is resourcefulness, force and willingness to learn, and ability to sell the value of health work to the people, and to get things done. These make a health officer a great asset to his community, and they certainly are not confined or peculiar to the medical profession or developed by medical training.

Recording an Act of Public Service

Out of the floods which put many Ohio water supplies out of commission in early August comes a story which we are glad to publish, as told by the State Board of Health. Millersburg, O., was without water for three days and had no facilities for chlorination. Aid was sought from the State Board of Health, which, in turn, called on the Columbus representative of Wallace & Tiernan Co., asking for a chlorinator. None was available in Columbus, but a request was relayed to Cleveland and a little later the W. & T. Cleveland representative called the State Board of Health with the information that no machine was available there, either, but that sufficient parts were on hand to put one together, and that he wounld get busy at once.

At nine o'clock in the morning—the first call for help went to W. & T. at midnight—the Millersburg supply was being chlorinated and the water was safe. During the intervening nine hours, the machine had been assembled, taken to Millersburg and put into operation.

Congratulations to Mr. Orchard and to his organization.

Highway Engineers and State Traffic Officials Should Cooperate

Of the forty miles of 3-lane highway between Suffern and Middletown, N. Y., roughly one-third is marked with a traffic line in the center, thus making it in effect a 2-lane highway in which passing is impossible without crossing the line against regulations. The same is probably true of almost every other similarly situated 3-lane highway in the State.

When so marked, the third lane is practically null and void so far as useful service goes. It is a waste of money, and a big waste. Where only two lines of traffic is permitted, only two lanes are economically justified.

If the state highway engineers had consulted with the chief traffic officer and had explained the plans to him, it is quite possible that the highway engineers would have found out in advance of construction most of the points where three lines of traffic were not permitted. Then they could have done one of two things: Built a 2-lane road, and with the money saved thereby, built 6½ miles of 2-lane road some other place; or built a 4-lane road, thus permitting a full flow of traffic over these 13 miles.

The same thing is true in just about every state in which we have motored, so that the New York highway engineers aren't any worse than those of other states. In fact, they generally do a fine job on the layout and design, as well as the construction, of their highways. But we cannot see any reason for building 27 feet of road when only 18 or 20 feet is used.

Opportunities in Less Well-Known Phases of Engineering

An announcement by Sol Pincus, recently appointed a deputy commissioner of health of New York City, that 150 engineers, chemists and other scientists will be employed on a comprehensive survey of smoke and air pollution in New York City, reminds us once more of the many lines of work in which engineers are needed. Another field which, just at this season, is engaging the attention of many engineers is that of snow control. Not only does snow removal pay for itself in increased gasoline tax income, but it promotes the flow of business so that the winter months are no longer, even in the rural sections, a time of hibernation and of slow trade.

The engineer, with his experience in handling men, and in planning and carrying out work, plus the background of his technical training, may often find opportunities for employment in some of these lesser known, though important, phases of engineering.

Measuring Rainfall, Runoff, Stream and Storm Water Flow

NEEDED data on rainfall include accurate records of the amount of rainfall, and of the intensity of rainfall. Upon these factors, to a very large extent, depend the yield of watersheds, flood possibilities, and storm water flow.

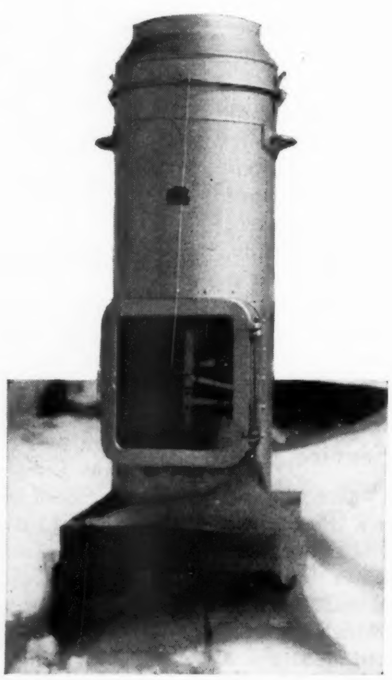
Quite a few of the larger cities have established gauges for measuring the rainfall, and the U. S. Weather Bureau has stations scattered over the nation where such data are collected. It is usually the case, however, that little information is at hand for the engineer concerned with a particular problem. The carefully kept records of the rainfall and yield of a few watersheds, principally in the northeastern part of the United States, have been about all that is available to engineers elsewhere. As a result, it has been necessary to take such information and try to fit it to conditions that may be totally different. We also find engineers in interior cities trying to use, as bases for design of storm sewers, the intensity and runoff data obtained by New York, San Francisco, Philadelphia and other large cities. We believe that practically every city would find it advantageous to obtain some data of this sort.

Needed Rainfall Data

Data on rainfall, for yield of water sheds, should show the amount of rainfall, but need not necessarily indicate the intensity of rainfall, which information is a necessity when securing data for storm sewer design or on possible flood flows.

Rain, snow, hail and sleet are all included under the general designation of precipitation. The amount of rain falling is measured on the basis of the depth of water which would accumulate on a level surface if there were no run-off, absorption or evaporation. Snow, hail and sleet are measured on the actual depth or weight, or by melting and obtaining equivalent depth of rainfall. It is preferable to measure snowfall in the latter way, since the relation between depth of snow and water equivalent varies greatly. The equivalent depth of water may be as great as one-seventh, or as little as one-thirty-fourth the snowfall. Where it cannot be measured by weighing or melting, it is customary to take one-tenth the measured snowfall on a level open place as the water equivalent.

To insure accurate measurements, gauges must be placed carefully, being greatly influenced by wind eddies and currents. A position in an open field, unobstructed by large trees, buildings or fences, is best. Low bushes, fences or walls should be at a distance not less than their height. When roofs are used, as may be necessary in obtaining rainfall intensity data, the gauge should be located in the middle portion of a flat, unobstructed roof, preferably at least 60 feet square. In such a position, results will not differ materially from those collected on the surface of the ground.



A rain gauge. Note drifted snow.

A rainfall record extending over 35 years will give results dependable within 2½% of normal, plus or minus. Records for five years cannot be considered as giving dependable values within 15% or 20%, plus or minus. (See PUBLIC WORKS, March, 1934, p. 13.)

Types of Rain Gauges

The U. S. Weather Bureau Standard gauge has a receiver exactly 8 inches in diameter, inside, and is provided with a funnel-shaped bottom which conducts the rain into a cylindrical measuring tube 20 inches high and 2.53 inches in diameter. The depth of water in this tube is just ten times the amount of rainfall, thus allowing a more exact measurement. An outside attachment retains the overflow from rainfalls of more than 2 inches.

A dial registering gauge is also available, which is compact and light, standing but 11 inches high and weighing but 6½ pounds. The same funnel collector is used. This conveys the water to a tipping bucket, which tips automatically on receiving each hundredth inch of rainfall, and registers each tip on the dial. The dial reads up to 12 inches, and indicates the depth of rainfall since the last reading.

A weighing and recording gauge is also available. This also allows an estimation of the rate of rainfall, since the amount of rainfall is recorded directly as an ordinate against time as an abscissa. As rain is collected, the pen goes higher and higher on the chart, stopping its rise on the cessation of the rainfall. If evaporation takes place, the pen falls on the chart, and the whole cycle is repeated at the next rainfall. To compute the total fall over a given period it is necessary to add the maximum ordinates, thus allowing for the amount evaporated between rains. The rate of rainfall can be quite accurately computed from the chart. One of these weighing and recording gauges will thus provide information regarding intensity of rainfall, as well as amount and spacing.

A recording tipping bucket gauge and a rain recorder, both after the pattern of the Weather Bureau, are also available, and these can be equipped with batteries and wires so as to register at a distant point, as in an office.

Measuring Runoff

The amount of rainfall is important, of course, but for water supply or power purposes the

amount of runoff is more important. Also, the relation between rainfall and runoff having been determined, it is possible to utilize rainfall records extending many years into the past to determine over a longer period of time the expected yield of a watershed.

The measurement of runoff is ordinarily accomplished by means of a continuous record of the water level. A stilling well is constructed for a float, the well being free from currents, waves, debris and other influences which might affect the accuracy of the record. As the water level rises or falls, the float, through a recording device, makes a continuous record of the level.

This record, however, is but the first step in determining the actual flow. If the water passes over a spillway of a weir, computations are relatively simple. If the stream bed is in its natural state it is difficult to get an accurate measurement. Cross-sections of the stream channel must be made for some distance up and down stream, and also determinations of current velocities at various stages of the river.

For installations recording river stages, considerable flexibility is necessary, since rivers may rise many feet above low water levels. In a recent continuous water stage recorder manufactured by a leading scientific instrument company, an accuracy of at least 0.015 foot is provided throughout the entire range which, in standard models, is at least 72 feet. This instrument records the time element and the water stage element on a chart. For better accuracy, a chart paper is used which is moisture resistant and has a very low coefficient of hygrometric expansion, and various rates of paper travel are provided so that the gauge will operate for a long period without change, or will indicate rising or falling levels more sharply.

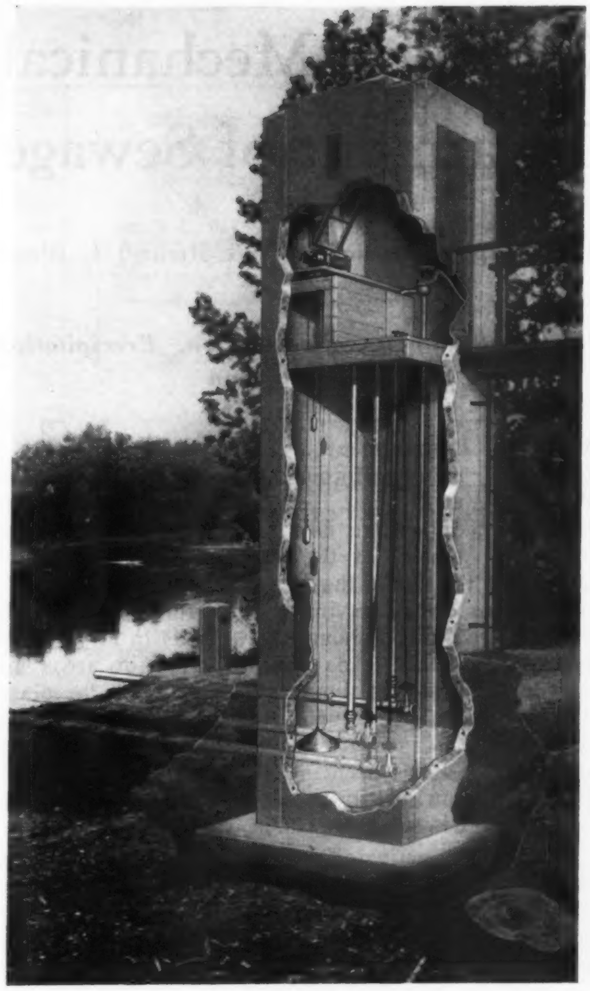
Such recorders may be supplied with supplementary electrical equipment for the distant transmission of the water stage.

Measuring Storm Water Flow

One of the most interesting projects for a city would be the installation of a rainfall intensity gauge on a watershed and a storm water runoff recorder to measure the storm flow passing through a sewer or other discharge channel. By synchronizing these two pieces of apparatus, the rate and intensity of the rainfall and the amount of runoff—which can be computed from the size and grade of the sewer or channel—can be checked against the original design and used also as a guide for future work.

Such apparatus being portable, a single team of rainfall recorder and float gauge could be moved from one drainage area to another, or a pair of them could be used on watersheds or drainage areas of different characteristics to provide comparison.

Continuous water stage recorder unit



An installation of a Friez continuous water stage recorder

A float or recording gauge would work on the same principle as the gauge for recording stream level or flows over a weir, but would not ordinarily require nearly as great flexibility as the former. In sewer work, the maximum range would not exceed 10 or 15 feet in large cities and 36 to 48 inches in smaller ones. Consequently a simpler and less expensive unit is possible. The stilling well for measuring the flow could be constructed alongside a manhole. This well should generally not be less than 18 inches in diameter to accommodate a 10-inch float, but may be larger.

Importance of These Data

The yield of watershed is an important factor in the water supply of many municipalities, and knowledge of this factor is of great importance in developing new sources of supply. Rainfall affects nearly all water supplies, both ground and surface, and long-term data over as wide an area as possible are needed for reliability. It should be the duty of every water department to keep records of rainfall and of runoff.

From another but equally important point of view, storm water runoff data are needed. Instruments for this work and for measuring both rainfall and water stages are not costly.

The Editor has available a number of booklets on rainfall measurement, stream flow and runoff gauging, directions and instructions for procedure, etc., which will be sent on request.

Chemical-Mechanical Treatment of Sewage

By Philip B. Streander* and Michael J. Blew†

III—Pretreatment, Flocculation, Precipitation and Filtration

More Uniform Plant Load Pretreatment of sewage will provide a more uniform load on the chemical treatment plant. It is well known that the rate of sewage flow fluctuates hourly, the intensity of the variation being controlled largely by the size of the sewer system. In a relatively small sewer system having a quick run-off, the hourly variation is quite pronounced; whereas in large sewer systems the peak loads from districts or areas are smoothed out by the time required to reach the plant. In addition to the volume, the suspended solids content of the sewage varies hourly, and when variation in both flow and concentration of the sewage are compounded it can readily be seen that the incoming load on the plant is subject to large variations.

As in the activated sludge process, pretreatment serves to remove the variations in the incoming load, and the applied sewage will therefore be more uniform in concentration. Also the removal of a major portion of the settleable solids will reduce the amounts of coagulating chemicals required and will tend to simplify the adjustment of chemical dosage, as the coagulation required is that of the colloidal or pseudo-colloidal solids.

Pretreatment Methods Pretreatment of sewage can be done in a primary or pre-settling tank, or by passing the sewage through what is termed a "coal mat" filter, both of which will serve to remove the major portion of settleable solids. With

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†Research Engineer, Philadelphia, Pa.

Fig. 3. Dorr flocculators.

pretreatment units, the chemical sludge from the final settling tank can be returned to and mixed with the raw sewage, whereby the thin chemical sludge is mixed with the thicker raw sludge and a more concentrated sludge is obtained for treatment and disposal.

Additions of Inert Materials

Application Questonable Various attempts have been made to improve flocculation and precipitation of the solids by adding inert material to the sewage, the theory being an increased crystal density and improved flocculation. There is nothing particularly new in this, as it was tried frequently in the old order of chemical treatment and consisted of the addition of clays, charcoal, ground charred bone, paper pulp and various fibrous materials. Numerous patents were taken out covering these additions under various claims. This same condition is now being duplicated, there having been numerous patents granted recently covering the additions of various inert materials.

Improvement of flocculation by the addition of inert material is problematical and extremely controversial. Adding these to a sewage which can be efficiently flocculated by coagulating chemicals only tends to increase the amount of chemicals used by the added amount required to coagulate the clays, dusts, etc., with very dilute sewages it may be of some slight benefit due to the increased density obtained by this addition, possibly securing a more quickly settleable floc.

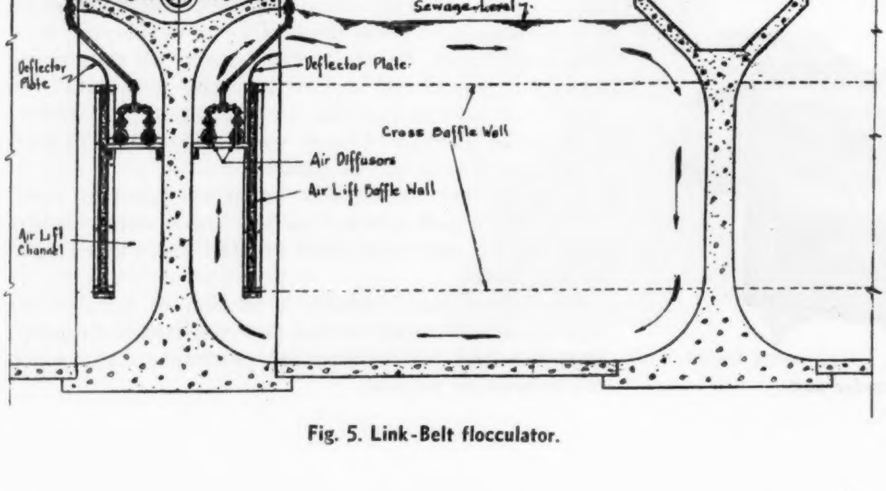


Fig. 5. Link-Belt flocculator.

Benefit Is In Sludge Treatment Whatever benefit there is in these additions is not in improved flocculation, but rather in the improvement of the sludge cake. Paper pulp increases the fibre content of the dewatered sludge and makes it easier to handle. Clays, cement dust and other similar materials give a harder and more dense sludge cake. If the sludge is to be burned, paper pulp provides added heat for incineration, but clays, cement-dust, etc. increases the amount of fuel required. To improve the sludge cake, the inert materials should be added to the sludge and not to the sewage.

Present Status The only large-scale operations adding inert material to the sewage are at Dearborn, where paper pulp is an integral part of the process, and at Atlanta on a 500,000 gpd experimental plant, where Cottrell dust was added. At Atlanta no definite conclusions were reached, and at the rebuilt Dearborn plant the use of paper pulp is being discontinued. Extensive experiments made by the authors indicated no improvement by the addition of either paper pulp or clays, the only effect noted being a tendency toward the more rapid clogging of the filter bed.

Flocculation and Mixing

General Principles Minute particles of insoluble substance are formed immediately following the introduction of the chemicals. These minute particles are not capable of crystallizing so that the growth of these, or agglutination, must be obtained by the aggregation of the minute particles. This aggregation is brought about by some external influence such as stirring or mixing, convection currents or sedimentation. Proper mechanical mixing or agitation causes a rapid aggregation of the particles, whereas with settling the particles are brought together at a very slow rate. Turbulent mixing causes the disintegration of the aggrandized floc and throws it back into the minute crystal or semi-solution form. Therefore the manner of mixing should be such as to effect a relatively slow, wide-sweeping motion in which the particles are brought gently into intimate contact with each other. The rate of floc formation is increased by an increase in the number of particles in a given volume of sewage (due to the increased probability that more floc particles will come together during mixing) as by the return of previously formed floc and the mixing of this with the chemically treated raw sewage; which also produces more efficient coagulation due to the characteristic of presenting a larger surface per unit of volume With an increase in the floc surface per unit of volume there is presented more area on which to build up the newly forming floc. Such a method requires a rapid primary mixing for dispersion, followed by a relatively slow secondary mixing for floc formation and the return of a portion of the secondary mix to the primary mix.

Types of Flocculators Various types of mixers, or so called flocculators, are available for use, and the designing engineer should carefully study all prevailing conditions to determine the type which seems best suited to the installation. It must be borne in mind, however, that the type of flocculating mechanism used, or its arrangement, is largely influenced by the kind of coagulating chemicals used. It would therefore be preferable to use a type which is adaptable to any combination of coagulating chemicals. Equipment for flocculation tanks is furnished by various manufacturers, some of which will be described.

The Dorr Company makes a combined flash-mixer and flocculator. The flash-mixer operates at a comparatively high speed and serves thoroughly to mix and diffuse the chemicals with the sewage. This is followed by a slow moving set of paddle wheels which give the sewage a slow rolling motion and causes an intermittent return of previously flocculated sewage to the lesser flocculated sewage.

The flocculator shown in Figure No. 4 (Filtration Equipment Corp.) consists of a mixing chamber in which the chemicals are mixed with the sewage, followed by a flocculating chamber having paddles parallel wth the flow which are rotated about 90 degrees, imparting thereby an across the tank motion to the sewage. Both of these types cause a partial return of coagulated solids to, and mixing with, less coagulated matter and give the sewage progressively intermittent forward motion.

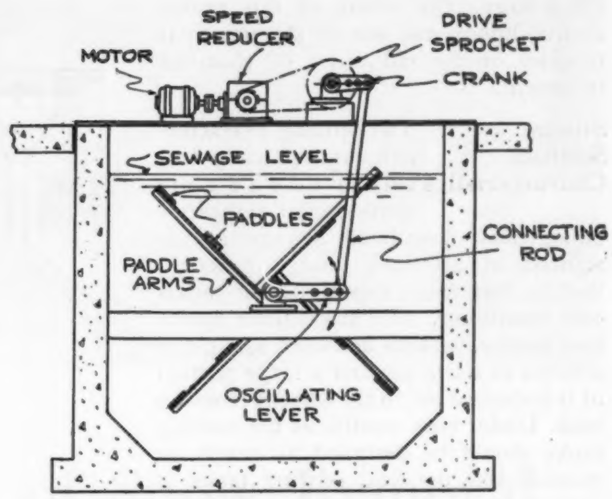


Fig. 4. Asch reciprocating floccer. Speed of paddles and length of stroke are adjustable.

Another type of flocculator, shown in Figure No. 5, (Link-Belt Co.), consists of elevated air diffuser tubes placed in an air lift channel constructed longitudinally with the tank. Air blown through the tubes imparts a rotary motion to the sewage in the tank and with sewage entering at one end causes it to flow forward in a spiral motion similar to the action obtaining in an aeration tank.

The flocculation tank shown in Figure No. 6 (Municipal Sanitary Service Corp.) consists of an influent pipe extended to the updraft tube where the chemically treated raw or pretreated sewage is mixed with previously flocculated sewage in any required proportion. The combined chemically treated raw and flocculated sewage is partially mixed in the draft tube, the mixing being completed in the air-lift head, which also produces circulation of the sewage in the tank. The air lift head is provided with curved diversion vanes which are entered across the splash plate and gives the sewage an outward spiralling or rolling motion, causing it to floc rapidly. A part of the flocculated sewage flows toward the center of the tank and is discharged from the tank through the effluent pipe. The balance of the flocculated sewage flows spirally downward and is mixed with the entering sewage. This type of tank is continuous in the mixing, flocculation, dispersion and diffusion, aeration, and in the reflocculation of the sewage solids.

Aeration of Sewage Aeration of the sewage immediately after the chemicals have been added is often advantageous and may, with certain sewage characteristics, result in more efficient coagulation. This aeration produces an effective mixing at a stage in the process when it is most needed. It also results in the liberation of carbon dioxide and other toxic gases present in the sewage. With a ferrous salt as the coagulant, aeration for oxygen absorption is an essential part in the formation of the insoluble ferric-hydroxide. Aeration is also a means of preventing any reversion of chemical reactions and causes them to go progressively forward to completion.

Precipitation or Settling

Tanks Mechanically Cleaned Tanks for precipitation and settling, or the separation of the coagulated solids from the sewage liquor, have a variety of forms and arrangements. Irrespective of the shape of the tank, mechanically operated scrapers should be provided for the continuous removal of the precipitated sludge. This is self-evident, as the deposited sludge contains the major portion of the organic matter of the sewage and unless this is continuously removed, decomposition will commence at a rate depending on the age of the solids, with the consequent return of putrefactive liquor to

the sewage. The return of this putrefactive liquor was one of the principal troubles of the old order of chemical treatment.

Sludge Settling Characteristics The settling characteristics of chemically flocculated sewage are quite similar to those of biologically flocculated sewage as instanced in activated sludge practice; that is, they settle rapidly under quiescent conditions. Also the lighter flocculant matter, as with activated sludge, is difficult to settle out and a large portion of it is carried out in the effluent from the tank. Under such conditions the settling tanks should be designed as nearly as possible like the final settling tanks in activated sludge practice. Velocity should be kept low, long effluent weirs should be provided and the speed of the sludge scraper mechanism should be kept at a minimum to reduce as much as possible any disturbance to the settled sludge.

Types of Tanks Circular, radial-flow tanks are well adapted to the settling of chemically treated sewage, as they have the various operating features required by the characteristics of the chemically flocculated sewage. Rectangular tanks also are well suited, especially if they are provided with a suitable system of effluent weirs arranged to skim a large area of the tank. Sufficient operating data are not available to make any actual determinations covering the relative efficiency of settling tanks, or the most economical capacity per unit of area. The maximum velocity of flow through the tank should be less than the settling rate of the flow, or, from present indications, should not exceed two feet per minute, and the area of the settling tank should be such as to maintain an average rate of 1200 gallons per day per square foot of settling tank area.

Factors Influencing Tank Design The detention period to be provided is influenced to a large extent by the kinds and amounts of chemicals to be used for flocculation and whether or not the effluent from the setlling tanks is to be mechanically filtered. With a heavy dosage of quick-forming floc chemicals, shorter detention periods can be used, for the floc formed, under proper coagulating conditions, will be heavier and larger and therefore will settle more rapidly. A shorter detention period can also be used where the effluent from the settling tank is to be passed through efficient sand filter beds, as these can be used to strain or filter out the more minute chemical floc particles. It is the small or so-called pin-point floc which requires long detention periods, and their removal by other means therefore reduces the required tank volume. Being subject to the variations in the sewage, the kind of and dosage of chemicals, etc., no hard and fast rules can govern the detention period to be provided in the settling tanks, as this is largely affected by the characteristics of the sewage, the kind and amounts of flocculating chemicals used, the efficiency of the rate and character of floc formation and whether or not the effluent is to be filtered. With the present knowledge of the settling of chemically treated average sewage, detention periods of between two and three hours should be provided if the effluent is not to be filtered and between one and two hours if efficient filter beds are used as final treatment.

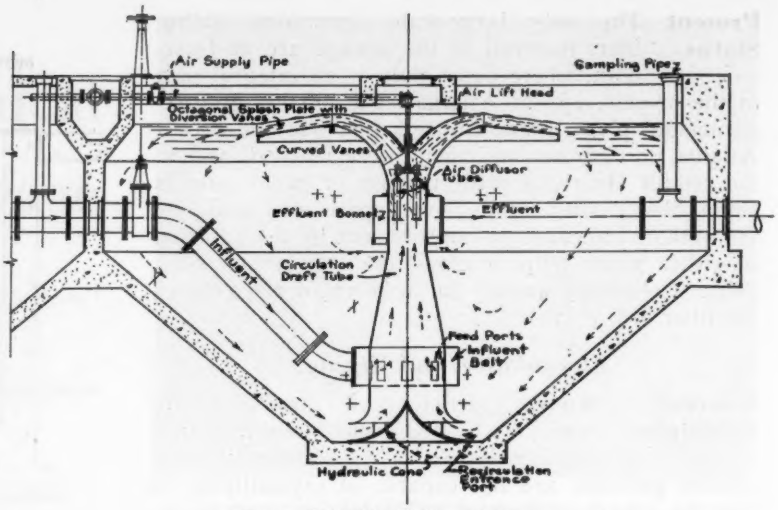


Fig. 6. "Municipal" flocculator.

Grease Removal In plants using a ferrous salt, lime and the artificial application of oxygen in the form of minute air bubbles to convert the coagulant into the insoluble ferric hydroxide, a large percentage of the ether soluble matter is removed from the sewage. This same condition also exists in plants using a ferric salt, lime and compressed air for mixing and flocculation. The removal of this large percentage of ether soluble matter is due to the formation of insoluble soaps by the action of the iron and lime on the solubles and the flotation of these by means of the air bubbles. At the same time the minute air bubbles liberate the film of mineral oils and greases from the sewage solids which are enmeshed in the froth of insoluble soaps. Unless equipment is provided in the flocculation tank for the removal of this floating froth it will be carried into and will collect on the surface of the sewage in the settling tank. In such an instance specially designed baffles and scum removal equipment should be provided in the settling tank, as the discharge of this into the filter beds, if used, will cause a rapid clogging of the filter medium.

The fourth instalment will appear next month

The Longest Straight Road

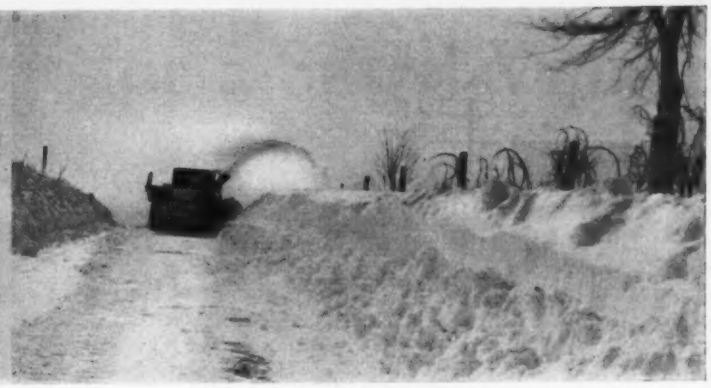
The Mississippi Delta, famous for its cotton and claimant to the greatest cotton growing county in the nation—Bolivar—can also pride itself upon possessing one of the longest straightest paved highways in the world, says "Mississippi Highways."

The claim might be questioned by some who have traveled over apparently straight roads in other states and who, unable to detect a slight gradual curve, are deceived by what seems to be a straight road.

But Coahoma County has on Highway 61 from the east outskirts of Clarksdale to a point just south of the Coahoma and Tunica County line, a ribbon of concrete 20 feet wide and 16 miles long said by many engineers and highway authorities to be the longest tangent, or absolutely straight road to be found anywhere.

The highway was completed a year ago and is part of what is proposed to be a 35-mile tangent. With the completion of this 16-mile road, which passed through nearly as many miles of cotton fields, the distance between the two points was reduced 3.2 miles, and 65 curves, two grade crossings and several inadequate bridges were eliminated.

This happens



when this doesn't

The Why and How of Snow Removal in Indiana

By C. W. McClain

Engineer of Maintenance, Indiana State Highway Commission

THE State of Indiana removes snow and ice from the entire system of 9,000 miles of highways for which it is responsible.

Does Snow Removal Pay? — The very fact that there is such a concerted and persistent demand for snow removal and just as continuous complaints if roads are not kept open shows conclusively that snow removal is considered a necessity. During the winter months there is very little pleasure driving. Traffic using the roads is business bent and any interruption to such traffic costs money. Certainly it pays those depending on an uninterrupted trip and if such trips are taken, money for gas tax will come in for road purposes. If the roads are blocked it is just as certain the road revenue will cease during the interruption.

C. W. McClain

We experienced a sudden snow storm on one of our principal roads which came just before daylight. Because of the suddenness and severity of the storm, the road was almost impassable before the plows could get to it. I got through this road early and on the twenty miles met five cars. The road carries a daily average of 3,800. If for the twenty miles each of these cars used one gallon of gas, our revenue from this road would be $76.00, based on the State's part of 2c per gallon. Twenty miles to the gallon is perhaps even too conservative. Our cost for snow and ice removal last year on this section was $49.40 per mile. These figures prove that a slight interruption to service means loss of revenue for the road, to say nothing of time loss and many times serious inconvenience to the road users. This loss also extends to filling stations, restaurants, hotels and many other kinds of business depending on the open road.

Our men are instructed to clean all surfaces as quickly and completely as possible. We consider melting snow very detrimental to our surfaces, especially to stone and gravel macadam. Also, if traffic is concentrated in two tracks the traction of tires combined with the churning action of impounded water from melting snow will cut through or seriously impair any surface, paved or unpaved. If these ruts through the snow freeze, a real hazard exists. I know of no argument against dividends paid by snow removal.

Demand for Snow Removal—The promptness of removal of snow from the highways depends of course on the severity, suddenness and scope of the storm. Normally our costs for this work are about $150,000 per year. County road snow removal is entirely independent of the State, but in some cases we have a courtesy exchange on this work. A friendly rivalry has grown up in some places between the State and some of the counties as to which unit will get its roads opened first. Before our forces were organized to the point where they are now, some of the principal bus lines carried plows. They have now almost entirely discontinuing this practice. We maintain roads through towns of 3,500 population or less and of course remove snow in such towns. We are besieged by towns larger than these to open their streets and are sorry we can't comply. This merely shows the demand for this service.

Ice Control—During the past winter we had an unprecedented amount of ice. On all curves and grades we stock a mixture of cinders, sand or stone screenings and calcium chloride. Where ice forms, these are applied with hand shovels by the patrolmen. The calcium chloride keeps the screenings piles from freezing and when applied sets the grit into the surface of the ice. On tangents we distribute mixtures of fine aggregate and calcium chloride or sodium chloride as soon as possible. This is done by hand, scattering from the trucks or by mechanical spreaders.

As soon after this as possible we start removing the ice coating. One of the most effective means for this we have found is a notched blade on a grader. An ordinary grader blade is cut in notches by cutting back about six inches alternately. In most cases the notched blade

At the left a snow blockade. At the right an open road, with snow moved back off the shoulders.

will cut grooves in the ice and crack that in between so it can be removed by an un-notched blade following. If the temperature rises sufficiently, the previously mixture coated ice can be removed with only the straight blade.

Equipment—Our equipment is tending towards high speed, light one-way plows. These we start with the storm and continue their operation until the storm abates. Some heavy equipment is necessary as a supplement to this in case of drifting or unusually heavy and sudden storms. We have now the following equipment available:

222 graders, 8′ to 12′ blades
121 single blade plows
88 V-type plows
2 Rotary plows

The above equipment is powered with appropriate trucks and tractors, which of course are used for other duties when not removing snow.

Our purchases of new equipment will depend on new mileage added to the system and any necessary replacements to our present equipment.

Lead Pipe for Handling Corrosive Chemicals

A number of modern industries require the use of chemicals corrosive to metals. Because of the high resistance of lead to many corrosive chemicals, particularly those commonly used, such as sulphuric acid, lead pipe is very widely employed in handling and transporting them. Where no great strength is required, chemical or soft lead pipe is generally used. If greater strength and rigidity are needed, antimonial lead pipe may be employed. In a few cases, as handling salt water or hydrochloric acid, antimonial lead is more resistant to corrosion than soft lead. Where neither of these types of lead pipe have sufficient strength, lead-lined iron or steel pipe may be used.

A new alloy of lead with a small amount of tellurium has been developed in England and is now generally available from American lead manufacturers. It has properties which indicate excellent possibilities, particularly for chemical work. More complete information can be obtained from manufacturers.

As a rough guide to the proper selection of lead pipe the following list of corrosive chemicals includes common corrosives with which lead is successfully used, but it by no means specifies all such chemicals, nor does it signify that lead is best under every condition. It is always wise to consult a reliable lead pipe manufacturer for such technical service:

Aluminum Sulphate
Ammonia Vapor
Ammonium Sulphate
Antimony Tri-Chloride
Bleach Liquors
Brown Acid Mother Liquor
Corbonates, soluble
Chlorine Gas
Hydrofluoric Acid
Koch's Acid
Malachite Green Mother Liquor
Mixed Acids
Nitration Mixture of H—Acid
Para-nitrophenol
Phosphoric Acid
Phosphorous Chloride
Reductions
Sodium Bisulphate
Sodium Chloride Solution, or sea water
Sodium Hydrosulphite
Sodium Hyposulphite
Sodium Sulphate
Sodium Sulphide
Sodium Sulphite
Sulphonations
Sulphur Chloride
Sulphur Dioxide
Sulphuric Acid
Sulphurous Acid
Sulphuryl Chloride
Zinc Chloride

Highways and Taxation to Be Studied by Ohio Road Experts

A Highway Survey Committee which was appointed by Governor Martin L. Davey to make a study of primary and secondary highways and of taxes, under the chairmanship of Dr. William E. Wickenden, president of Case School of Applied Science, will gather information on the following subjects over a twelve months' period:

1. Determination of the amount of traffic now carried over the various state trunk highways, over county or secondary roads, and over local or third-class roads. Also determination of the percentage of total traffic carried by the various classes of thoroughfares.

2. Determination of the amount of motor-vehicle revenue paid by rural and urban motorists.

3. Ascertain what are equitable motor taxes and secure equitable distribution of motor tax revenues in relation to needs and use.

4. Ascertain the percentage of total travel carried on city streets and the relationship to revenue paid.

5. Development of a long-time program to eliminate waste, duplication and inefficiency, thereby furnishing the groundwork for an adequate highway system commensurate with present and future requirements.

This program, as well as the information gathered during the study, will provide an unbiased, authorative guide for legislative highway policies in the future.

Sewage Treatment for a Small Village

By George L. Robinson

IN designing a sewage plant for a large city, the engineer is justified, obligated in fact, to include in it the most up-to-date mechanical devices and chemical treatments that have demonstrated their effectiveness; but in the case of a small community he must bear in mind the financial limitations and probable necessity of operation by untrained attendants, and simplicity of design is the only answer. A typical case is that of Waverly where, although it is a small community, a high degree of purification was desired.

Waverly, Lackawanna County, Pa., is a distinctly high-class suburban community of some 400 population living in detached houses provided with public water supply. There are no manufacturing plants of any kind. The one large public school receives some children from outside the village.

The village is situated on a hillside, so that all sewers can be carried with adequate grades to the site of the disposal plant. This plant, which is now under construction, consists of a screen chamber with bar screen; Imhoff tank planned for 40,000 gallons per day flow; a sludge valve manhole; an open sand bed for drying Imhoff sludge; a siphon chamber, discharging tank effluent onto a broken stone sprinkling filter; a re-settling tank for sprinkling and sludge filter effluent; a chlorinating plant complete together with laboratory equipment for making simple pH and B. O. D. tests; and a sand filter for the chemically precipitated sludge from the re-settling tank.

The Screen Chamber, at the inlet end of the Imhoff tank, will be 8 ft. long by 5 ft. wide, containing a two-section bar screen made up of bars ½" x 2" x 7' long, spaced one inch apart by ring washers strung on ¾" rods, and bent at the upper end to permit scraping of detritus onto the perforated steel drip plate.

The Imhoff tank is designed to give a detention period of well over two hours for a flow of about 40,000 gallons per day. The sludge digestion chamber has a capacity of more than 400 cubic feet to give the longest possible intervals between sludge withdrawals.

The sludge filter bed provides for about 1½ square feet of area per capita, having 25 ft. x 25 ft. of sand area, and a depth of 24 inches from surface to underdrain invert, of which 9 inches is very coarse, clean, sharp mortar sand over 3 inches of broken stone or gravel ranging from ¾" to ½". The 6" underdrains are surrounded with 1" broken stone.

The 5" *dosing siphon* is of the Pacific Flush-Tank type, and will operate on a total nozzle head of about 5½ feet.

The *sprinkling filter* area provides a rate of 1,800,000 gallons per acre per day. The filter medium will consist of particles passing a 3-inch circular opening and retained on a 1½-inch opening, held in place by concrete walls of reinforced concrete 8" thick. The floor is 6" thick, of reinforced concrete. The underdrains are 8" vitrified half-pipe laid in valleys molded in the concrete. There are 14 Pacific Flush-Tank nozzles spaced on centers 9.25 feet by 8.0 feet, 3 of them whole and 2 half-nozzles, 5 deflectors, 2 double deflectors and 2 half-spray deflectors. This nozzle grouping is planned to take the flow from the Imhoff tank under any rate not influenced by storm water or infiltration.

In a house provided for the purpose will be a manual control solution chlorinator, the diffuser to be placed in a "trap" mixing tank. The final chlorinated effluent, after it has passed through a re-settling or mixing tank of reinforced concrete 12 ft. by 6 ft by 8 ft. deep at the inlet end, will enter the nearby brook.

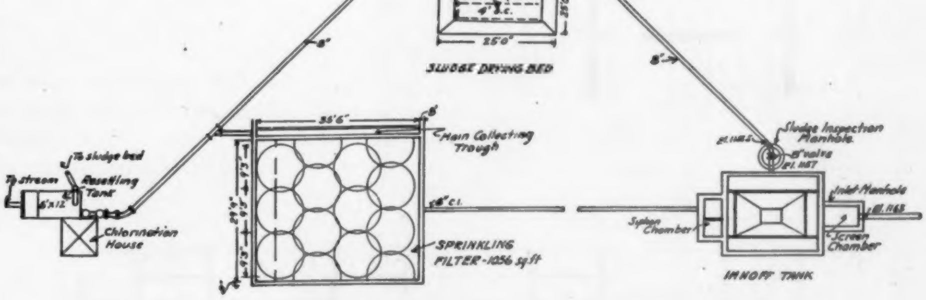
In the chlorine house will be provided water connection and a table with some simple laboratory equipment for making determinations of relative stability (methylene blue), settleable solids and residual chlorine. The apparatus called for is as follows:

24 bottles, narrow mouth, ground glass stoppers, cap. 250 cc.
3 Imhoff cones, cap. 1,000 cc.
3 bottles, glass stoppered, cap. 5 pts.
12 bottles, wide mouth, cap. about 250 cc., with corks to fit.
1 wash bottle, cap. 1,000 cc.
1 bottle, narrow mouth, ground glass stoppered, cap. 1,000 cc.
2 pipettes, Mohr, cap. 1 cc. calibrated in 1/10 cc.
1 ring stand, base 6½" x 9", rod 36" x 7/16" without rings.
1 ring with screw clamp, dia. 3".
1 funnel glass, short stem dia. 5".
1 Orthotolidin testing, special disc for Hellige Comparator representing chlorine from 0.1-2.0 parts per million, in nine steps.
10 grams methylene blue.
¼ lb. glass wool, coarse.
5 gallons distilled water.

This plant is being built with funds provided by the State Emergency Relief Administration of Pennsylvania for labor, and other funds provided by Abington Township authority.

The estimated cost of the work is as follows:

State employment labor	$43.500
Materials and equipment furnished by Abington Township	15,800
Other items in the budget are: Transportation of labor, Legal fees, Engineering fees, Insurance and miscellaneous, making a total of	5,900
Estimated total cost of the work	$65,200

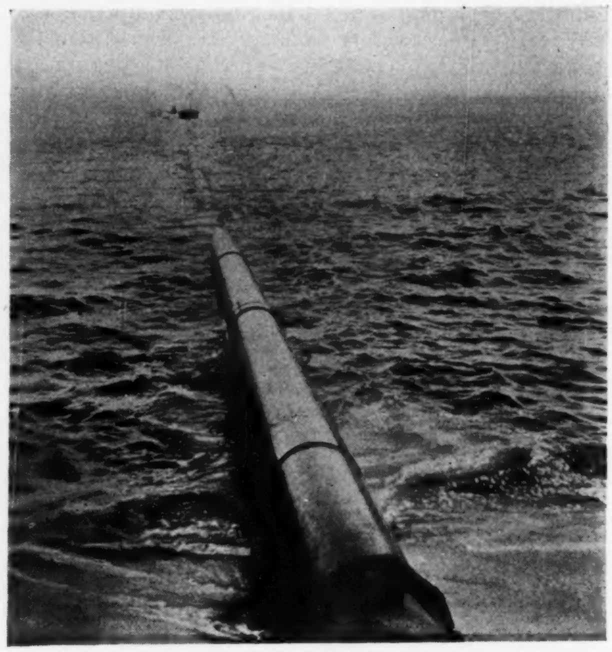


Layout of the Waverly disposal plant

The project, carried on as it is under the handicap of winter work relief, will no doubt cost some ten per centum more than it would under direct contract.

The project was developed and brought to a successful conclusion for the Village of Waverly through the great energy and highly intelligent work of Mr. Searle H. von Storch and the Honorable Cadwallader Evans, Jr., who spent many weeks in overcoming the numerous difficulties which attend a problem of this kind. The writer acted as consulting engineer.

Laying a Thousand-Foot Sewage Sea Outfall



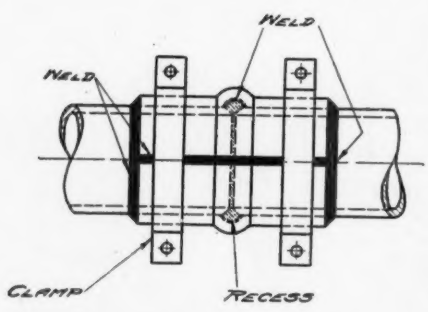
Outfall nearing completion.

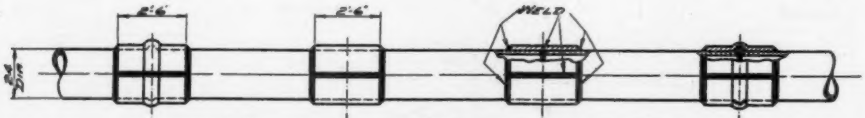
ASBURY PARK, N. J., recently laid a 24-inch sewer outfall, employing methods that involve some interesting details. The outlet was constructed of wrought-iron pipe with walls ½ inch thick, extending a little over 1,000 feet into the ocean. The beach and the ocean bottom for the full length of the outfall were of sand.

The pipe was purchased in 20-ft. mill lengths which had been triple-lengthened at the pipe mill into 60-ft. sections, which were delivered on the job with the section ends beveled for welding. In order to add weight to the line and corrosion resistance to the circumferential joints, each of the two joints in each section was fitted with a 2′ 6″ sleeve of ½″ thick wrought iron; the weld reinforcement first being ground down flush with the pipe surface, and the split sleeve then being slipped into place, after which the longitudinal and the two circumferential seams of the sleeve were welded.

The contractor's problem was joining these 60-ft. sections together and carrying the line out into the ocean. Ways were built shoreward from the water's edge, pointing in the exact direction of the outfall, and slightly sloping skids at one side of the ways. Three 60-ft. sections were lined up on the skids and blocked in place, and welded into one 180 ft. section, which was then rolled into the ways. For moving the pipe longitudinally into the ocean, a donkey engine was set up just at one side of the inland end of the ways, a cable running from the engine to the water's edge, passing here through an anchored cable sheave and then back along the pipe, to which it was attached. Winding up the cable pulled the 180 ft. section into the ocean. The front end of the first section was blanked off with a bolted flat head, which was later removed by a diver.

A bell hole was dug near the water's edge for making the tie-in welds, and first section hauled out until the inner end was over this bell hole. A second section was then welded up, rolled into place on the skids, tack welded, then welded together and a sleeve welded into place. Then this 180-ft. section was moved into the water and the next added.





Sleeve anchors and reinforcement details.

In welding all the joints, high test steel welding rods were used. In making the joints between 60-ft. sections, after welding had been completed a heavy anchor and reinforcement split sleeve was placed over the joint. Unlike the other sleeves, these were formed to fit over the reinforcement of the weld. When a sleeve had been placed in position it was clamped to draw the edges together and the longitudinal seam was oxwelded; then the two girth seams at the ends of the sleeve were welded to the main pipe with a fillet type weld.

As this pipe was sealed at the outer end, it floated, and to provide ballast to stabilize it in the heavy seas, a 4-in. pipe with screw collars was placed in the 24-in. pipe and extended and carried out with it, through which pipe water ballast was pumped into the larger pipe. A cable had been fastened to the outer end of the 4-in. pipe, and when the outfall had been completed the smaller pipe was pulled back to land.

This work was done by the Thomas Proctor Company, of Long Branch, N. J., for the city of Asbury Park.

Here's a NEW Truck Tire!

. . . It'll Work Better In Any Going

GRIP! PULL! Here's a tire that likes the "bad lands." It's the new Goodyear Heavy Duty Lug Type Balloon—built to do the kind of work your trucks do.

Notice those heavy diagonal bars across the tread. They grip, they bite down, they drive ahead in ANY ground—they clean themselves as they go—and they roll smoothly on hard surface roads. That thick, heavy tread is made of rubber chemically-toughened to resist the tearing, gouging and cutting that destroys ordinary tires. And underneath that tread is a tough, durable body of Supertwist cord that provides unmatched strength and endurance.

In mud, snow, over broken ground, on rough rocky roads, in ruts, over soft ground, in sand, or even on pavement—wherever your trucks go, whatever the job they must do, they'll work better and more economically with this new Goodyear Heavy Duty Lug Type Balloon.

Put this new tire to work on your trucks. Pick the toughest jobs for it. Then watch it PERFORM. You'll know what we mean when we say—It's a MONEY SAVER.

THE GOODYEAR TIRE & RUBBER CO., INC., AKRON, OHIO

• Maximum Traction • Self-cleaning tread design • Continuous Grip • Reinforced Sidewalls • Smooth running — constant road contact • Supertwist Cord Body • Patented Bead Construction • Chemically-toughened rubber • A product of the world's largest builder of truck tires.

CALL THIS MAN—He is the Goodyear Truck Tire Man. He represents the most complete line of truck tires made. Behind him are all the years of Goodyear's experience in the design and application of truck tires for every type of business—for every job. He'll pick the RIGHT tires for your trucks. His services cost you nothing. He'll save you money.

GOODYEAR

LUG TYPE BALLOON

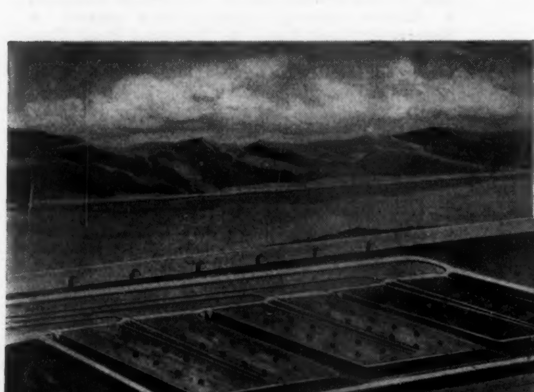
An Eight-Billion-Gallon Water Clarification Plant

THE largest water treatment plant in the world, it is believed, is to be built by the Bureau of Reclamation to clarify 7.776 billion gallons a day of Colorado river water which is to be used for irrigation after flowing through 210 miles of the All-American canal. This river at times carries 2,800 ppm. of silt, most of which would be deposited in the canal, where the velocity of flow will be much less than in the river. Although the cost of the desilting plant is estimated at $38,500,000, it is calculated that this will be more than liquidated by the elimination of the dredging of the canal that otherwise would be needed. Dredging the existing canals now costs the farmers of the Imperial Valley about $1,400,000 annually.

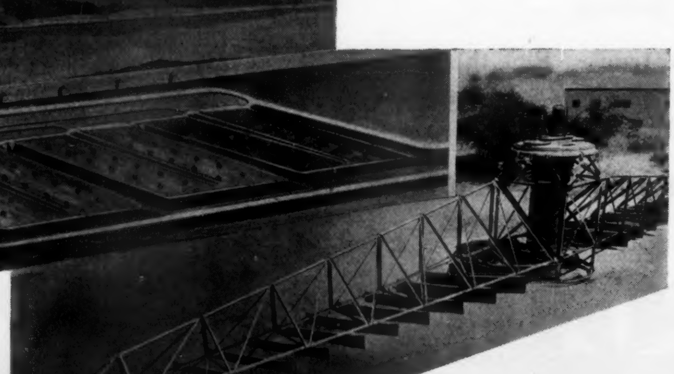
This plant will be located on the Colorado river about 15 miles northeast of Yuma, Ariz., at Imperial Dam, 250 miles below Boulder Dam. It will consist of six settling basins, each 769 ft. long by 269 ft. wide, with an average depth of 14 ft., arranged in pairs. Each pair will be fed by an influent channel located between them, which will receive water from the headworks at the west end of the diversion dam, where the rate of flow is to be controlled by four roller gates, each 75 ft. long and 23 ft. high. The silt deposited in these basins will be removed by 72 mechanically operated Dorr clarifiers, each 125 ft. in diameter, and similar to those furnished by that company for sewage treatment and water purification. It is anticipated that only about 78 per cent of the silt—that retained on a 270 mesh standard screen—will be retained, but this will amount at times to 70,000 tons a day. This sediment will be returned to the river below the canal intake.

The desilting plant, designed by the Reclamation Bureau's engineers with the collaboration of the research and engineering staffs of The Dorr Company, Inc., of New York, is the result of six years of field study supplemented by research and development work on both a laboratory and semi-commercial scale. At one point in the investigation 35 tons of Colorado river silt were shipped from Yuma, Ariz., to the Dorr Company's laboratories at Westport, Conn., where for several months a Dorr clarifier treated and retreated 3,600,000 gallons of water and 24 tons of solids a day under the conditions anticipated in practice. This semi-commercial scale work, 2,500 miles from the site of the proposed desilting plant, developed the basic engineering factors on which the final plant design was made.

The construction and operation of this project is under the jurisdiction of the Denver, Colo., office of the Federal Bureau of Reclamation, R. F. Walter, chief engineer, and J. L. Savage, chief designing engineer. The plans developed by the Reclamation Bureau engineers were reviewed by a board of consulting engineers consisting of Charles P. Berkey, Dr. W. F. Durand and Dr. Louis C. Hill.



Above — General view of clarification plant on Colorado river.



Part of one of the seventy-two clarifiers

Automatic Reduction of Pipe Corrosion

For several years past the Maryland Bureau of Sanitary Engineering has been studying the internal corrosion of distributing mains in several municipalities, among them the city of Cumberland. It is found that the supply there is fairly aggressive to new mains but does not attack the older ones, mains appearing to become practically immune in less than 10 years.

Water entering the system averages about 72% dissolved oxygen saturation. In 1931, in one section of the system 9 months old, it showed 6.37% saturation, and 30.9% three years later. In another section, the saturation was 12.46% when one year old and 53.77% three years later. At still another point, where the mains were four years old in 1931 the percent saturation was 15.41 but three years later was 71.49.

Says Abel Wolman, chief engineer of the Bureau, from whose annual report this information is obtained: "It is believed that the protection provided for the older mains is largely due to the compact type of film or coating produced by this water through the slow accumulation of the products of the corrosion reactions and precipitation of material from the corroding medium. A protective coating of this character tends to insulate the corroding water from the metal surface and to exclude the dissolved oxygen. The water is within 0.3 value for pH and 5.0 ppm for alkalinity of those values at which the water is in calcium carbonate saturation equilibrium. Under such conditions the solubility of the ferrous hydroxide should be at a minimum at the same time that corrosive action is weak and slow, thus providing a compact film rather than a soft, porous coating which would be more easily penetrated by the oxygen in the water."

Costs on Rural Road Work

"I am engaged by the county to make reconnaissance surveys and to estimate the cost of certain rural road improvements for incorporating this construction in the Works Program. It is a new type of work and the results I have so far obtained lead me to seek further information on costs. I need some data on the cost per cubic yard for road grading and for digging banks in widening work; the costs for making shoulders; the cost of ditching; the cost per foot for laying sluices and drains, etc. I realize that these costs vary with the locality, the season and the times, but I would like to have some basic figures for comparison with my own, which are largely guesswork. Also costs on surface treatment, macadam, and retread, and information on proportion of labor to the cost per mile."

It appearing to the Editors that the information asked for in the request quoted above might be of use to many other engineers engaged on the same class of work, the data furnished in reply thereto are presented herewith, slightly rearranged.

COSTS do vary with the locality, with the extent of the use of machinery and equipment, and with the type of labor and supervision employed. Relief labor is not generally so good as the type of labor formerly employed on public works construction, but even relief labor varies; in rural counties, for example, it is much better than it is in urban areas.

Clearing and Grubbing—The usual bid price on this work is $100 an acre. It may run in actual cost to $150 an acre, which was the case on a force account project in Rhode Island last year. In a rural section where men are accustomed to work of this sort, and considering the small amount of clearing and grubbing contemplated in the work mentioned, this usual price should be a fair basis for estimating. If trees are to be removed, exclusive of clearing, an allowance of about $10 per tree should be made, though the cost may fall below this.

Earth Excavation—This will be of two types, that necessary in connection with widening and reducing curves; and that necessary in grading the surface of the existing highway. In the former, the cost will depend upon the amount per station involved, and on the extent of the use of machinery. In average going, using a power shovel and trucks, the cost should not exceed 35 or 40 cents a cubic yard, even with a considerable haul. Using hand labor and trucks, the equivalent costs will be 60 to 90 cents a yard. In the harder soils, which can be handled readily enough with power shovels, but which require dynamite or continuous pick-work with manual labor alone, the costs by hand may be three or four times the cost by machinery; that is, they may run to $1.25 or $1.50 per yard.

The costs for grading the road surface and preparing it for a gravel or bituminous surface may be expressed in any one of three ways: Cubic yard, square yard of surface, or lineal foot of road. On rural road work, the yardage per station will be small and the costs per cubic yard will be high. Six contracts in 1934 averaged 12½ cents per square yard. These were high-type pavements and consequently the costs were perhaps more than may be expected with similar use of machinery on rural road work; but with hand labor the costs will be higher, especially where dirt is packed and there are many small and large stones.

A rural county in New York which in the past year

(Please turn to page 34)

ASPHALT HITS A *on the*

ASPHALT FOR PAVING . . .

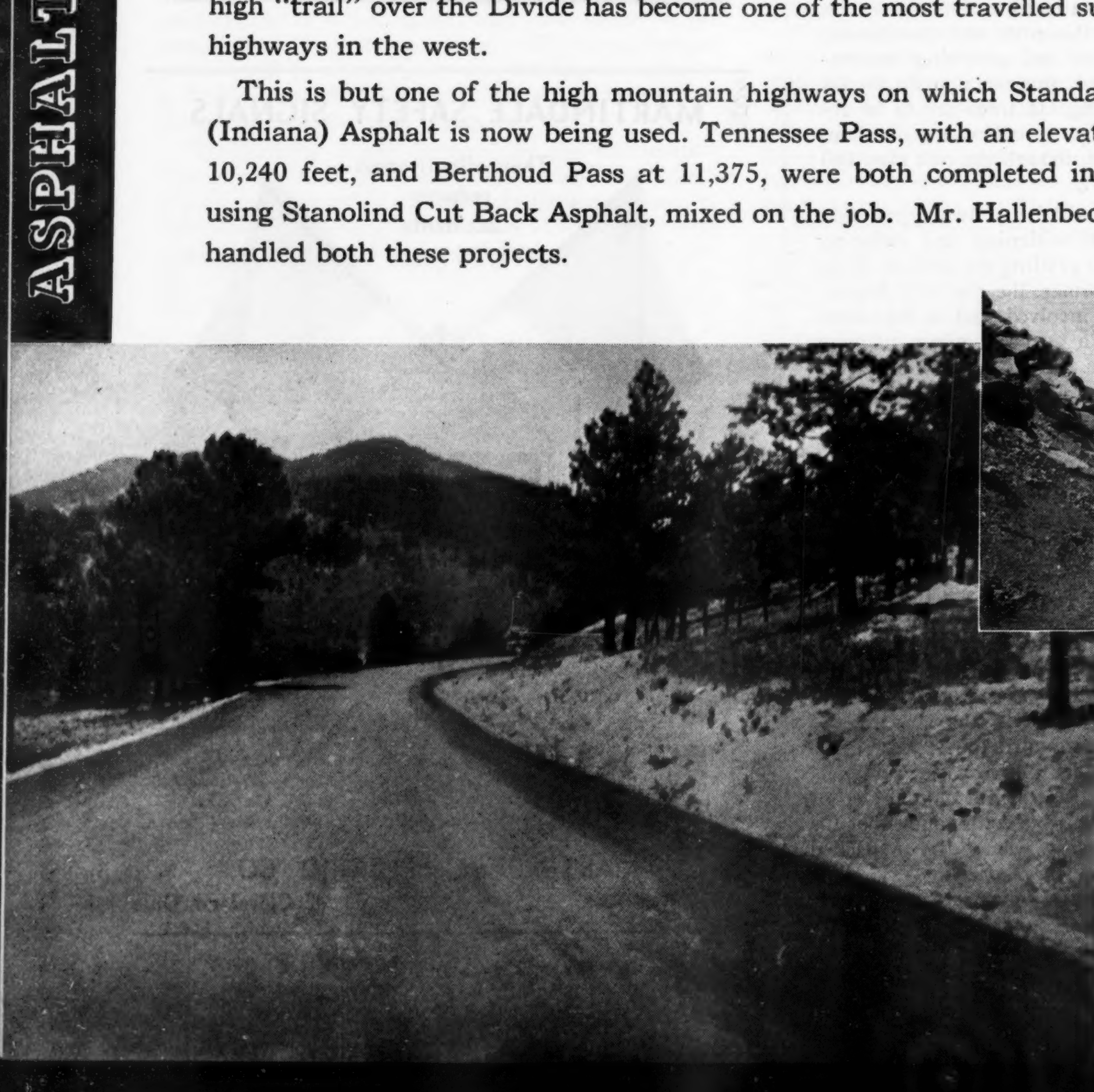
The highest point on the Fall River Pass Highway, 12,183 feet, affords a horizon of unsurpassed grandeur to motorists rolling over the fine modern pavement this road has received

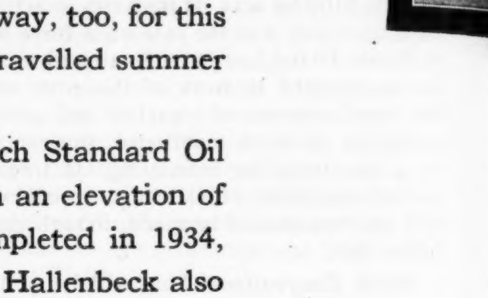
Showing base treatment before final, non-skid surface was laid on the highway

Here's snow, in the middle of July!

WITH a completely truck-mounted portable asphalt plant, and a crushing plant cut, out-of-the-traffic, into the side of the mountain, Contractor C. V. Hallenbeck makes, and mixes, his materials right on the job. He carefully keeps his equipment out of the scenic right-of-way, too, for this high "trail" over the Divide has become one of the most travelled summer highways in the west.

This is but one of the high mountain highways on which Standard Oil (Indiana) Asphalt is now being used. Tennessee Pass, with an elevation of 10,240 feet, and Berthoud Pass at 11,375, were both completed in 1934, using Stanolind Cut Back Asphalt, mixed on the job. Mr. Hallenbeck also handled both these projects.





"Comin' 'round the mountain," and placing a light bituminous treatment on the base course surfaced road. At this point, up beyond the timberline, work is being carried on at 11,000 feet

Here's the finished highway! Easy-riding, easy on the eyes, and non-skid throughout its length. A typical Stanolind Cut Back Asphalt surface—expertly laid

"NEW HIGH" OF USEFULNESS

Highest Through Highway in the world!

Paving the Fall River Pass National Highway, under the supervision of the Bureau of Public Roads

TOPPING the Continental Divide, and affording an unbroken view of the most rugged peaks of the Rockies, the Fall River Pass Highway in Colorado is now the highest paved through highway in the world. Its pavement is a non-skid surface of Cut Back Asphalt.

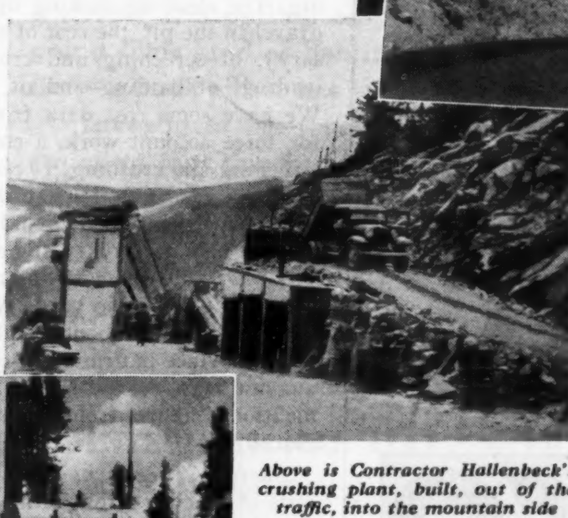
Rising to a height of 12,183 feet, and open, heretofore, only five months of the year, the paving of this highway presents many unusual problems. The men responsible for the success of the work deserve great credit. Climate, altitude, and the necessity of keeping the road clear, and scenic beauty unmarred, for tourists—these things and many more had left the job a virtually "impossible" one for many years.

All practical considerations, including the importance of a non-skid surface for safety, dictated the selection of Stanolind Cut Back Asphalt.

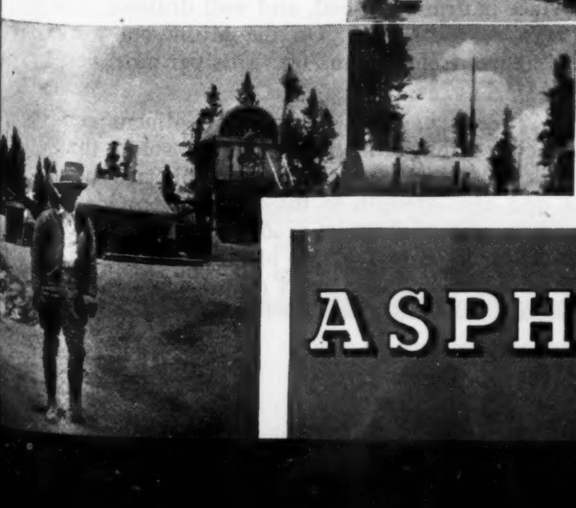
Above the timberline here. That slope drops off to one-half mile below! But this well constructed, non-skid highway has no grade greater than 7 degrees!

Snow-capped mountains through the pines. Here we see base treatment on the highway, ready for its Cut Back Asphalt surface

You're at the entrance to Fall River Pass National Park Highway here. In a few minutes you can be up there in the pines, rolling over modern Asphalt pavement, wondering at the snow-capped beauty of Long's Peak



Above is Contractor Hallenbeck's crushing plant, built, out of the traffic, into the mountain side



Below: Here's C. V. Hallenbeck, contractor, and part of his completely portable, truck-mounted equipment

ASPHALT *for every Purpose*

ASPHALT FOR PAVING . . . ASPHALT FOR PAVING . . . ASF

has built more than 50 miles of farm roads, found that, using relief labor at 40 cents an hour, 1½-yard dump trucks at $1.25 per hour including driver, tractor and grader at $2 per hour with one operator, and a roller at $2 per hour with operator, the cost of rough grading for a 15-foot road was 8 cents per lineal foot. This is about 5 cents per square yard.

Rock Excavation—Bids on rock excavation on highway work has run from $2 to $6 per cubic yard. Under the conditions encountered in relief labor, costs should be much higher, unless enough rock is present to justify the proper equipment for drilling.

Shoulders—The New York county referred to above built an excellent shoulder and improved the ditch, using a 6 to 8-inch layer of broken stone over the shoulder and down into the ditch, covering this with dirt or sand, and rolling. The costs per lineal foot of road was 10 cents, or about $525 per mile.

Ditching—In average going, it will cost about 70 to 80 cents a foot for hand trenching with depths not exceeding 5 feet. This was the cost on several thousand feet of sewer built by hand labor in a rural New York village during the past summer. It is also the average for seven fairly recent highway contracts. A 9-foot trench will cost around $2 per foot in good going, and $2 should be allowed for each added 4 feet of depth. The presence of rock will greatly increase the cost, whether in ledge form or in the shape of large boulders.

Laying Pipe and Culverts—For furnishing the pipe, laying it and backfilling, the cost per foot will be about 40 cents for the smaller sizes (6 and 8-inch), increasing rapidly for the larger sizes due to the greater cost of the pipe, the greater difficulty in handling, and the increased amount of joint material.

Prices for culverts are pretty well established. Using corrugated metal, the cost for furnishing and laying 12-inch pipes will average around $1.60 per foot; for 18-inch, the cost will be somewhat over $2 per foot; for 24-inch about $3 per foot; for 30-inch, $3.75 to $4.50; and for 36-inch from $7 to $8. Reinforced concrete may cost more or less, depending on the locality. Vitrified tile is usually cheaper, but is less desirable for heavy work of this type.

Gravel and Macadam Costs—It is comparatively easy to make an estimate on the cost of gravel surfacing. The elements making up the total are the cost of gravel in the pit, the cost of stripping (if this is necessary), of screening and crushing (if necessary), of loading, of hauling and of applying and spreading. We have some cost data from Minnesota which give, for force account work, a cost of 40 cents a yard for screening and crushing, 10 cents a yard for loading and 6 cents a yard-mile for hauling. The New York county previously mentioned found that the cost per cubic yard of hammer broken stone in place on the road base was $1.70 and the cost of gravel or shale top in place was $1.00 per cubic yard. A 6-inch top on an 18-foot road will require about 1,700 yards of gravel per mile. If the surface is firm and good, and well drained, this amount may not be needed. On the Minnesota work mentioned above, from 500 to 700 yards per mile were placed.

Surface Treatment Costs—Surface treatment consists of placing a thin bituminous layer, not more than 1 inch thick, on the surface of the road. This treatment does not add any strength to the road; it provides a smooth-riding, watertight, dust-proof and durable wearing surface. From ½ to 1 gallon of tar or asphalt will be required for each square yard of surface area, de-

Take the Rock and Dirt Away in INTERNATIONALS

● At BONNEVILLE: One of the fleet of International heavy-duty Model A-8 dump trucks owned by D. A. Whitley, Spokane, Wash., hauling contractor, at work on the sea locks that are being cut through solid rock to permit ocean-going vessels to pass around the new Bonneville Dam in Oregon.

SOUND engineering design and quality construction have their best innings in dump-truck service. No severer test can be given a truck than working under a shovel and pulling out of places where there isn't any going. This kind of hauling leaves nothing to the imagination—a truck either has the stuff, or hasn't.

Investigate the record of International Trucks on construction jobs the country over. For example, you will find Internationals on the big dam projects of today, rendering the superior performance which their ALL-TRUCK quality assures. Their work in the past is your guarantee of what they can do for you in the future.

Ask our nearest branch, or International dealer, for a demonstration. Sizes from ½-ton to 10-ton.

INTERNATIONAL HARVESTER COMPANY
OF AMERICA
(Incorporated)
606 So. Michigan Ave. Chicago, Illinois

INTERNATIONAL TRUCKS

pending somewhat on the type of surface. An open surface requires more bituminous material. Stone chips and sand complete the materials for the mat. Detailed information on construction will be furnished on request. Surface treatment costs will run from 8 to 12 cents a square yard, as a rule, or $800 to $1,200 per mile of 18-ft. roadway.

Retread or Mixed-in-Place—There are variations of this method of surfacing, and the costs will depend upon the type of treatment. On the Minnesota work mentioned, a 1½-inch mat was placed, and the costs ran from 16 to 21 cents per square yard. Both tar and asphalt were used on the different jobs. The cost for the bituminous material in that state varied from 6 to 10 cents a gallon, plus application cost of slightly less than 1 cent a gallon. In New York state these costs will be higher, probably around 12½ cents a gallon applied.

Detailed information on the methods of constructing road-mix or retread will be furnished on request. Distribution of the asphalt or tar must be made with a bituminous distributor, and certain other construction equipment is necessary to obtain a good job.

Labor Cost vs. Total Cost—There isn't a lot of information on this subject. The article on page 11 of the July issue of PUBLIC WORKS gives good data. With wages at 40 cents an hour, labor costs ran from 60% to 65% of the total cost for materials, equipment and labor. This is a pretty high average, but probably can be maintained on nearly all rural road work if the projects are carefully laid out and managed. A. J. Runnels of the Vermont Highway Department stated in 1934 that labor on the job received 35% of the cost of concrete roads, 45% of the cost of high-type bituminous roads, and 86% of the cost of gravel, surface treatment and mixed-in-place roads. In all cases, the proportion that went to labor included payments for trucks and teams as well as for labor. In the Sullivan County work mentioned in the July issue, it will be noted that a portion of the costs charged to trucks, tractors and rollers went to the operators and could be classed as labor.

Records of Long and Efficient Service

In a survey covering more than 900 cities of over 10,000 population, *Public Management* found a number of instances of outstanding tenure of office in the positions now held. Among these are the following:

City Engineer: John A. Jones, Lewiston, Maine, 50; Robert A. Cairns, Waterbury, Connecticut, 44; Emmett C. Dunn, Alexandria, Virginia, 40; Charles Hick, Mount Vernon, New York, 40; J. H. Dingle, Charleston, South Carolina, 39; Henry W. Estey, Malden, Massachusetts, 39.

Superintendent of Water Works: Fayette F. Forbes, Brookline, Massachusetts, 61; Arthur Brown, Fitchburg, Massachusetts, 52; W. W. Bridgon, Battle Creek, Michigan, 49; Paul F. Babbidge, Keene, New Hampshire, 47; H. S. Moulton, Willimantic, Connecticut, 47; Phil Carlin, Sioux City, Iowa, 44.

City Manager: T. W. McMillan, Mount Pleasant, Iowa, 19; G. J. Long, Webster City, Iowa, 18; J. H. Sanders, Crystal Falls, Michigan, 18; H. L. Woolhiser, Winnetka, Illinois, 18.

The average tenure of office for city engineers is 8.2 years for water works superintendents, 10.6 years; and for director of public works, 5.8 years.

Undoubtedly many officials in towns of less than 10,000 population have given equally long service. We shall be glad to hear from them, so that we may add their names to the list.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

The Digestion Tank

ACTIVATED sludge research was urged by officers of the Netherlands Government Institute of Sewage Purification in a paper before the British Institute of Sewage Purification. Purification and cost were considered the two items of outstanding importance but it was difficult to correlate them, which required a standard of measurement of the purification effected. The purification capacity of an aeration tank had been defined as the reduction in the BOD of the sewage effected by one cubic meter of tank volume in one hour while producing an effluent at the "limit of lability" (that state of purification at which nitrification begins). Purification capacity is still a rather unwieldy yardstick, and a second standard of measurement—oxygenation capacity (the oxygenation effected by one cubic meter of tank volume in one hour)—was introduced. This turned out to be a more tractable one, and by first comparing purification capacity with it, and then cost, the desired amenability to practical research was realized. In this it is assumed that purification capacity is dependent chiefly on oxygenation capacity. While purification is a combination of sludge production and biochemical oxidation, the latter is essential to the former and influences it in a manner and to a degree unknown. It is proposed to (1) find the relation between oxygenation capacity and purification capacity with regard to a given sewage; (2) find the relation between oxygenation capacity and the cost at prevailing prices, and (3) deduce the relation between purification capacity with regard to a given sewage and cost at prevailing prices. Methods are described for finding such relations for any given plant.[D9-1]

The first activated sludge plant built to serve an entire city is claimed by San Marcos, Tex., which plant was built in 1915 and is still in service, although an additional unit has been added which now receives two-thirds of the sewage. In the original plant air was applied through fifty-two 12" square filtros plates, one at the bottom of each hopper; but as these clogged, air is now applied through open-ended pipes, one just above each diffusion plate. The aeration period is 7.5 hrs., 3.43 cu. ft. of air per gallon being furnished. The settling tank provides a theoretical retention period of 4.7 hrs. The BOD is reduced from 140 ppm to 15, and suspended solids from 146 to 14. The present average flow is 300,000 gpd. Excess sludge is used for irrigation on a farm. Power costs $140 to $150 a month. Labor, one man on the farm and one general, costs $5.25 a day. Total operating cost $36.67 per million gallons treated, with no allowance for the superintendent's service or the offsetting stock feed raised on the farm.[E9-2]

The Southwest plant, Chicago Sanitary District, will be one of the largest activated sludge plants in the world, with an initial capacity of 400 mgd and provision for ultimate extension to 1200 mgd. It is located just west of the existing West Side works. There will be two batteries, each containing 8 aeration tanks and 16 settling tanks; the former giving 5 hrs. detention, 0.5 cu. ft. of air per gal., returned sludge average 20% sewage flow; final settling tanks designed for an average settling rate of 1200 gal. per sq. ft. per day. Air lifts will be used for sludge return. A sludge incineration process utilizing waste heat will probably be combined with a steam generating unit to operate steam turbine-driven pumps, blowers, etc. There will be preliminary settling and skimming tanks. The sludge will probably be dewatered and dried before incineration. The diffuser plates will be set with their upper face 6.5 in. above tank bottom, at one side of a tank 34' wide and 15' of water above the plates, giving spiral motion. Circular settling tanks with sludge-removing mechanism will be used (bids were received on both circular and rectangular), with 126 ft. inside diameter, water depth of 11 ft. at the wall. All air used will be measured by venturi meters. It is intended eventually to make the drawing off of sludge automatic by use of photo-electric cells in connection with sludge level indicators, the cells controlling the sludge air lifts.[E9-1]

Heating digestion tanks with sludge gas should be susceptible to thermal calculation if the various conductivity and other factors were known. The fuel value of the gas depends on the percentage of methane in the gas (60 to 75%), the temperature and pressure at which the gas is measured, and the quantity of water vapor in the gas. The net fuel value omits the heat of condensation of the entrained vapor (1 to 2% of the total). About 80% of this fuel value can be utilized in heating the tank and useful work. The heat required for keeping a tank at a desired temperature (usually 85° to 90°) is calculated as for heating water (although the specific heat of sludge may be somewhat less than that of water), assuming the temperature of the sludge in the coldest weather (based on previous records, if any), and allowing for loss of temperature in the tank to the surrounding earth and air. The last depends on the surface area of the tank. Average results from a few measurements give, as the BTU lost per hour, per sq. ft. of tank surface, per degree Fahr. difference between sludge and tank environment, for concrete entirely covered with dry earth 0.07; concrete, top exposed to air, remainder surrounded by dry earth 0.10; concrete, top exposed to air, sides in moist earth, bottom in ground water, 0.20 to 0.25. Scum is good insulating material and if kept stirred up the loss through the top is probably increased. Drainage of soil around the tank to keep it dry reduces loss and might be worth while.

In calculating length of heating coils necessary to heat a tank, formation of sludge crust on the outside of the pipe should be considered, since this is a non-conductor; but such formation probably is not serious if the temperature of the water in the pipe does not exceed 140° F. (The average of eleven tanks gives 133° entering temperature and 119° outgoing.) The coefficients (BTU per hour per sq. ft. of pipe surface per degree of temperature difference) suggested are 12 to 13 for concentrated sludges, 15 to 21 for medium sludges, and 15 to 27 for thin sludges. The coils should be so located as to encourage convection currents of sludge as much as possible.[C9-3]

Sludge as fertilizer should be applied with caution to soil on which are grown vegetables which may be eaten raw. While the nature of the sludge and the conditions under which it is stored and handled probably affect the health hazard greatly, sufficient data have been recorded to indicate the presence of viable B. typhosum cells in sludge. If used, the sludge should be added to the soil in the late fall, winter or early spring. Probably it should not be added to growing crops.[C9-2]

Activated sludge is a low-grade fertilizer and has a favorable effect on the physical conditions of fertilizers but is deficient in mineral plant food elements, and therefore finds its best use as a constituent of commercial mixed fertilizers, as a source of gradually available organic nitrogen and a conditioner to prevent caking.

Digested sludge contains 1/5 to ¼ as much available nitrogen as nitrate of soda, as compared to slightly less than half for activated sludge. Compared to farm manure, the more easily decomposable nitrogen compounds of the sludge have been more completely removed by the digestion process than is the case with manure, leaving a nitrogenous residue of lower availability; the potash, being mostly water soluble, has been largely washed out of the sludge; the phosphoric acid is slightly greater in amount.

Activated sludge may be used directly in the moist condition, or dried and ground for use alone or as a constituent of mixed fertilizers. Its value is barely high enough to permit processing for use dry, perhaps with a slight profit to the producer. Digested sludge in most cases has not sufficient fertilizing value to pay for dewatering beyond the sand bed stage, but may be used similarly to farm manure, than which its value is usually, but not always, less.[C9-1]

Sewer lining of Los Angeles county sanitation districts' sewers, laid in 1927, consisted of vitrified clay liner blocks and a sand-sulphur-silica mixture as jointing material. After 7 years of use, the concrete body of the sewer is in good condition where protected in this way. The sulphur-silica mixture between liner blocks shows some slight evidence of destruction on the exposed interior surface—approximately 0.07 in. depth when examined. In an experimental line, three 36″ pipes had been completely lined with a sand-sulphur-silica mixture 0.4″, 0.6″ and 1″ thickness respectively; and after eight years' use, at about the flow line of the sewage the lining had completely disappeared back to the concrete in the first two; and wherever the lining material had not been thoroughly bonded to the concrete, the concrete was destroyed for a depth of ½″ to ¾″. All other jointing materials used in this experimental line, including cement, tar and asphalt, had largely disappeared above the flow line although generally in good condition below.[E8-1]

Bibliography of Recent Sewerage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract), *t*, technical article.

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Sewage Works Journal

July

1. Adaptability of Sewage Sludge as a Fertilizer. By E. E. De Turk, pp. 597-610.
2. Public Health Significance of Sewage Sludge When Used as a Fertilizer. By F. W. Tanner, pp. 611-617.
3. *t*. Thermal Considerations in the Design of Heated Sludge Digestion Tanks. By E. W. Moore, pp. 618-627.
4. *t*. Plant Experiments on the Filtration of Settled Sewage. By W. Rudolfs, J. H. Brendlen and W. T. Carpenter, pp. 628-639.
5. Determination of Suspended Solids in Sewage by Light Absorption. By G. W. Holmes, pp. 642-657.
6. Possibilities of the Digestion of Garbage in a Sewage Treatment Plant. By H. E. Babbitt, pp. 658-662.
7. Disposal of Sewage from the South Essex Sewerage District, Salem, Mass. By E. Wright, pp. 663-672.
8. Sewage and Sludge Pumping. By H. Ryon, pp. 673-683.
9. Experiences at Newark Sewage Treatment Plant. By T. J. Smith, pp. 684-691.
10. Use of Activated Carbon at Garden City. By A. H. Rogers, pp. 691-694.
11. A Day at a Sewage Treatment Plant. By F. W. McCann, pp. 694-695.
12. Grease Removal at Hamilton, N. Y. By L. Waldron, p. 696.
13. Effects of Sewage Gases on Concrete. By A. F. Pistor, pp. 697-705.
14. Construction of a Sewage Treatment Plant Under a Relief Program. By R. C. Wheeler, pp. 706-712.
15. Recent Trade Waste Treatment Methods. By Willem Rudolfs, pp. 713-726.
16. Bacteriological Examinations of Oysters and Water from Narragansett Bay. By L. M. Fisher and J. E. Acker, pp. 727-741.
17. Sewage Treatment in the United States. By Karl Imhoff, pp. 750-758.
18. Relation of Industrial and Trade Wastes to the Municipal Sewerage System. By E. Stecher, pp. 758-760.
19. New Way of Chemical Sewage Purification. By H. Jung, p. 760.
20. Activated Sludge Process for Industrial Wastes. By E. Nolte, H. J. Meyer and E. Fromke, pp. 761-762.
21. Principles for Designing Activated Sludge Plants. By F. Leiner, p. 762.
22. Utilization of Carbohydrates and Proteins by Activated Sludge Organisms. By E. F. Eldridge, W. L. Mallman & G. H. Robinson, pp. 766-767.
23. Ignition Temperatures for Sewage and Sludge Solids. By E. F. Eldridge, p. 768.

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The Surveyor

July 19

1. *p*. Practical Activated Sludge Research. By H. J. N. H. Kessener and F. J. Ribbius, pp. 59-60.
2. *p*. The Davyhulme Disposal Works. (Discussion of D6-6), pp. 79-80.

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3. *p*. Digestion of Activated Sludge. By Edward Ardern and W. T. Lockett, pp. 89-90.
4. *p*. The Davyhulme Disposal Works. (Discussion of D6-6), pp. 91-92.
6. *p*. Practical Activated Sludge Research. (Discussion of D9-1), pp. 92-94.

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6. *p*. Discussion of D9-3. By F. R. O'Shaugnessy, J. Bolton, and others, pp. 121-123.
7. Recent Improvements in Design and Equipment of Detritus Chambers. By A. Johnson, pp. 133-134.

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Engineering News-Record

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1. Sewerage Planned for 1970 at Cedar Rapids, Ia., pp. 118-121.

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2. Chicago Starts Work on Fourth Large Sewage Plant. By L. C. Whittemore, pp. 186-188.
3. Frequency of Intense Rainfall in Iowa Analyzed, pp. 190-191.

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4. Pioneer Activated Sludge Plant (San Marcos) Still in Service. By E. W. Steel, pp. 222-223.
5. Sewage Treatment Facilities in the United States, p. 224 and table.

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Water Works and Sewerage

August

1. Sludge Incineration at Dearborn. By M. B. Owen, pp. 261-267.

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Municipal Sanitation

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1. Isolating Typhoid Bacilli in Sewage. By A. A. Hajna, p. 234.
2. Rapid City Plant Has Novel Features. By A. A. Chenoweth, pp. 235-238.

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American City

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1. Collecting Delinquent Sewerage Service Rates in Monmouth, Ill., p. 62.

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Canadian Engineer

July 23

1. *p*. Methods of Designing Storm Water Sewers. By W. L. Malcolm, pp. 7-11.
2. *p*. Sludge Dewatering and Incineration at Chicago, pp. 13-15.

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3. *p*. Methods of Designing Storm Water Sewers. By W. L. Malcolm, pp. 3-6, 9.
4. *p*. Bio-Aeration System of Sewage Purification. By S. Thornhill, pp. 7-9.

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5. Developments in Sewage and Sludge Pumping. By H. Ryon, pp. 13-16.

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Public Works

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1. *p*. Test of the Laughlin Tank at Chicago, pp. 17-18.
2. Difficult Sewer Construction by Force Account. By Olney Borden, pp. 23-24.
3. Activated Carbon for Activated Sludge Plants, p. 24.
4. Chemical-Mechanical Treatment of Sewage. By P. B. Streander and M. J. Blew, pp. 30-33.

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Contractors and Engineers Monthly

July

1. *c*. Ten Imhoff Tanks Added to Rochester's Sewage Works, pp. 2, 19.

Use of Local Stone In FERA Projects

IN CARRYING out FERA work, most engineers are confronted with a difficulty in the obtaining of material under the conditions imposed for such work and with limited funds. Larimer County, Colo., has in some instances solved the problem by using local timber and stone, cutting and sawing trees and quarrying stone from local quarries. The latter is considered especially satisfactory because of the durability of the resulting structures.

Culverts and bridges for road construction projects was one of the problems. In building culverts, a stone flag bottom was laid where the grade was such that there was danger of erosion; the walls then were laid up to the desired height and covered with heavy stone flagging and this covered with road surfacing.

Top—Stone archway. Second—Sewage disposal plant. Third—Chemical house, water purification plant. Bottom—Coagulation basin.

For the large structures, stone arch construction was used with good success. Great care was used in building up the proper footings for the walls. After the walls had been raised to their proper heights, the circular forms for the arch were put in place and the arch built up. Except on the outside walls, the key was made of concrete. Portland cement mortar was used throughout. Some of these bridges have been built in Commissioner Rausler's district for over a year without cracks or any sign of deterioration.

Colorado has on its statute books a law requiring all municipalities to treat their sewage before emptying it into the public streams. Although some of the municipalities have been putting off the construction of these plants as long as possible, others are taking advantage of FERA labor and going ahead with the construction of their disposal plants. At Loveland a sewage disposal plant designed by City Engineer L. C. Osborn is now nearing completion, using FERA labor throughout. The plant consists of an Imhoff tank, sludge drying vat and sprinkling filter, in constructing which stone with Portland cement mortar was used. The floor was constructed by covering the bottom with irregular flag stones just as they came from the quarries. A thin mixture of concrete was then poured over these, filling the cracks and then a finishing coat about 1 inch thick was spread over this.

Berthoud, a small town in the southern part of Larimer County, found itself in immediate need of a water treating plant, and R. A. Haworth, water commissioner, under advice of L. C. Osborn, consulting engineer, decided to build a 1,000,000 gal. coagulation tank and chemical house for the introduction of chlorine, lime and alum. Stone construction was used similar to that used in the sewage disposal plant at Loveland. The coagulation basin is 70 ft. by 100 ft. and approximately 8 ft. deep with a baffle wall in the center. The walls are 3 ft. 6 in. thick at the bottom and 18 in. at the top. The plant is now in operation, lacking only a few details of completion. All the work was done with FERA labor, and the outstanding feature is that not one of these men ever had any experience in masonry construction before. George Reisbeck, street commissioner of Berthoud, cooperated in a very helpful way during the construction of the plant. It is expected that many other structures of this type of stone construction will be built in Larimer County. W. E. Runge is FERA administrator and J. P. Collopy project engineer. The stone was quarried from the local deposits.

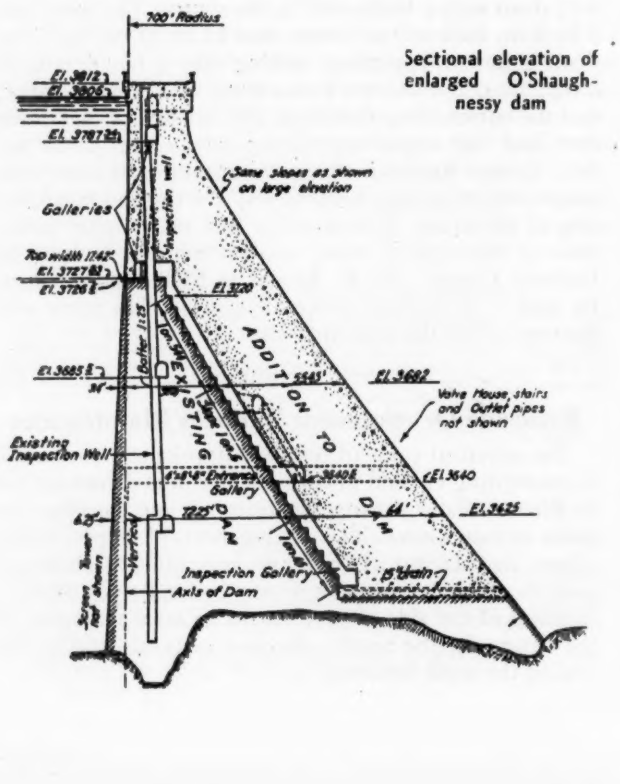
Roadside Development Reduces Maintenance

The practical value of roadside development as an aid in preventing erosion in cuts and fills was demonstrated in Rhode Island during the freezing and thawing periods of last winter. The cutting back of slopes, which allows the placing of drainage structures to eliminate pockets which develop dangerous ice conditions, and the treating of the side-slopes, should be more extensive in the future for the results obtained certainly justify the cost of the work involved.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

ENLARGEMENT of O'Shaughnessy dam was contracted for last April, 12 years after the completion of the original structure, as was originally contemplated, and will increase the capacity by 75%. The work is unprecedented and involves special construction features to insure that the entire mass of the enlarged dam shall act under stress in practically the same manner as if it had originally been built to the final dimensions as a whole. To provide for enlargement, the base of the dam was built full size, giving a shelf 80 ft. wide to support the addition; the downstream face was finished in steps 5 ft. high; copper water-stops were inserted in the crest surface, half imbedded in the concrete. At present the spillway consists of 18 siphons; these will be filled with concrete and a new side channel spillway built. The new crest will be 85.5 ft. higher than the old—312 ft. above stream bed. The new concrete, 50 to 75 ft. thick, will total 268,000 cu. yds. It will not be poured directly against the present concrete, but a space of about 5 ft. will be left, only narrow ribs being carried to the old face at intervals to support the new concrete; these being filled after the new concrete has attained most of its shrinkage, which will be hastened by artificial cooling of the concrete. By cooling it below the temperature of the old concrete, then grouting all the joints and allowing the temperature to rise it may be possible to induce stresses similar to those already existing in the old concrete and make the two act homogeneously. To insure bond of new with old, the surface of the latter will be roughened, notches cut, and 15 ft. anchor bars of 1¼ in. sq. steel set in holes 5 ft. deep spaced 2 ft. 6 in. horizontally and 5 ft. vertically.[A9-6]



Sectional elevation of enlarged O'Shaughnessy dam

Compacting embankment of Bouquet Canyon dam was effected by means of special sheepsfoot rollers, each weighing 8,000 lbs. and exerting a pressure on the soil of approximately 155 lbs. per sq. in. when operated at a 3 in. depth of tooth penetration. This size was determined by experiment, it being found to increase the dry weight of the compacted soil to 123 lbs. as compared to 117 lbs. with the customary light-weight sheepsfoot roller. Maximum density of the soil used was obtained when it was compacted at slightly over 12% moisture content.[A9-8]

Earthquake effects on elevated tanks are being studied by means of models at the Massachusetts Institute of Technology; also measurements of the vibrations of full-sized tanks have been made by the U. S. Coast and Geodetic Survey in California, and comparisons of results indicate that the model method is remarkably dependable. The studies of models "indicated clearly that truly quake-proof tank structures cannot be economically achieved with the present types of construction, and that a moderate amount of reinforcing (as is used in so-called 'quake-proof design' today) adds very little to, or may even reduce, the ability of the structure to withstand earthquake motions. Further research . . . is being directed toward the development designs for towers which are especially suited to seismic regions."[L9-1]

To resist earthquakes, the Morris dam was designed to resist a shock with an acceleration of 0.1 gravity, increasing the mass by 15%. The natural period of vibration for the dam as a whole was calculated to be 0.16 second or less—a shorter period than that of the more destructive earthquakes, and the probability of resonance to a serious degree seems remote.[A9-7]

Moving a water tank of 50,000 gal. capacity on an 80 ft.-tower without dismantling was performed at Mt. Vernon, Ohio, the tank being moved 91 ft. north and then 97 ft. east. On the hard ground a plank mat was laid along the route, on this a crib work of large timbers, and on this, steel rails. The bottoms of the four legs were tied together with steel beams, 4 large screw jacks under each leg raised them and framing was fastened to the legs to stiffen them and permit attaching counterweights to prevent the tank being tipped by wind. A hand-operated winch pulled the tank along the rails the 188 ft. in 2½ hours.[F9-8]

Water planning is necessary to the life of the nation. This includes erosion, and unless this is corrected within the next 20 years, less than 100 years of virile existence remains to the nation. The problem is a national one and its solution should be based on accurate hydrological information embracing all parts of the country, much of which information not only has not been acquired but is not being. "It is imperative that we begin at once a far more comprehensive and scientific approach to the investigation of our water resources, involving particu-

larly standardized and coordinated procedures for the collection, compilation, and publication of basic hydrological information." Investigation of the coordinated use of water resources can best be made under Federal auspices.[A9-3 and 4]

Sterilization of a water of a high or low organic content is increased in velocity and amount by the use of ammonia with chlorine; in either chlorine or chloramine treatment, the lower the pH the greater the velocity and amount. With chloramine, there is a lag in velocity at the higher pH values. At all organic loads chloramine sterilization was better in 30 min. than chlorine in 60 min., probably because di-chloramine is a better disinfecting agent than mono-chloramine because of its greater heat formation. With both treatments, using equal amounts of chlorine, residuals were higher at the higher pH values. At high organic loads the efficiency of chloramine sterilization is relatively more affected by additional organic matter than that of chlorine sterilization. At low organic loads, adding organic matter measurably retards simple chlorination but does not greatly change chloramine sterilization.[A8-7]

Synura cause tastes and odors which are difficult to handle because, even though at the time of testing the water may be free of apparent taste and odor, yet the same water drawn from the mains may be quite unpalatable due to a dry metallic sensation on the tongue. There is good reason to believe that the decomposition products of some protozoa like synura approach the state of a true solution more or less resistant to volatilization by aeration alone. Experience at Albany, N. Y., would indicate that even with the most efficient type of aeration under winter conditions, the reduction in odor at best is only 50%. Continuous copper sulphate treatment preceding aeration of an adequate period decomposes the cell material and renders it more responsive to aeration and coagulation, doubling the length of filter runs. Activated carbon, when properly applied in conjunction with filtration, will reduce the odor of a raw water of threshold concentration 64 to zero and produce a palatable effluent. Thorough mixing of the carbon is necessary and a long contact period; application at the outlet of the settling basins has outstanding advantages if there is sufficient retention period between this and the filters. Since the coalescing action of precipitants followed by deposition of floc and carbon on the filter surface reduces its efficiency, application of carbon to basin influents or directly to individual filter influents is not so effective as prolonged treatment of the clarified water, except where flocculation is improved or basin sludge rendered more stable. Synura decomposition products may be eliminated by adequate prechlorination followed by dechlorination; but high doses are necessary and Albany has found carbon treatment alone to be the more economical remedial measure.[A7-9]

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The boldface number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract), *t*, technical article.

A *Journal, American Water Works Ass'n*

9 *August*

1. The Drought of 1930-34 in Kansas. By Earnest Boyce, pp. 941-945.
2. The Effect of the 1934 Drought on Ohio Public Water Supplies. By W. H. Knox, pp. 946-948.
3. Water Planning for the Nation. By M. L. Cooke, pp. 949-963.

4. Deficiencies in Present Water Resources Information. By T. Saville, pp. 964-982.
5. Municipal Water Supply of Paris. By J. B. Hawley, pp. 983-985.
6. Some Engineering Features of the Enlargement of the O'Shaughnessy Dam. By L. W. Stocker, pp. 986-998.
7. Design and Construction of the Morris Dam for the City of Pasadena. By S. B. Morris, pp. 993-1016.
8. The Bouquet Canyon Dam and Inlet-Outlet Pipe. By W. W. Hurlbut, pp. 1017-1029.
9. Current Situation in the Public Works Program. By M. Pirnie, pp. 1030-1040.
10. Future Growth of American Cities. By C. A. Dykstra, pp. 1041-1048.
11. Economic Security. By H. M. Waite, pp. 1049-1054.
12. Reconditioning Water Supply Lines with Bituminous Enamel. By L. Stuart, pp. 1055-1064.
13. Cement Lining of Large Diameter Mains in Place by a Centrifugal Machine. By E. T. Killan, pp. 1065-1072.
14. Applying Cement Mortar Lining to Existing Mains in England. By T. H. Wiggin, pp. 1073-1081.

D *The Surveyor*
9 *July 19*
1. p. Water Softening at Cambridge, pp. 61-62.
2. p. Rural Water Supplies. By H. B. Gardner, pp. 65-66.
3. p. Design of Open-Air Swimming Pools. By J. M. Easton, p. 69.
4. Organization of Water Resources and Supplies, p. 70.

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5. Shrewsbury Waterworks, pp. 87-88.
6. p. Modern Methods of Management Control Applied to Waterworks. By T. G. Rose, p. 107.

E *Engineering News-Record*
9 *August 15*
1. Modern Water Supply for Ankara, Turkey. By F. A. Liefrinck, pp. 225-227.
2. Runoff of 34% Solids from Denuded Watersheds, p. 235.

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3. c. Watertight Pump Chambers for a Flooding Tunnel (San Jacinto), pp. 252-255.

F *Water Works Engineering*
9 *July 26*
1. Bouquet Canyon Dam Inlet-Outlet Pipe. By W. H. Hurlburt, pp. 726-730.
2. Street Space for Water Lines in Relation to Other Utilities. By E. W. Breitkreutz, p. 730.
3. Community Life (animal and vegetable) in Lakes. By R. E. Coker, pp. 731-733.

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4. Operation of a Mutual Water Company. By P. B. Hasbrouck, pp. 774-776.
5. Community Life in Lakes. By R. E. Coker, pp. 777-780.
6. Effects of the Drought of 1933-4 in Kansas and Lessons Learned. By E. Boyce, pp. 802,804.

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7. p. Soil Compaction Stressed in Dam Construction. By W. W. Hurlbut, pp. 830-833.
8. p. How Underground Supplies Are Polluted. By F. M. Veatch, pp. 838-839.
9. Hydraulically Driven Pumps Save Money for Seattle. By C. Lindsay, pp. 852, 855.
10. p. Experiences with Micro-Organisms in Washington Water Supply. By G. E. Harrington, pp. 855-856.

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11. Effects of Passing River Water Through Chain of Lakes. By R. A. Thuma, pp. 879-882.
12. Some Interesting Leakage Tests. By P. J. Dishner, pp. 883-886, 913.
13. p. Use of Inhibitors in Cleaning Pipes. By A. Abrams and C. L. Wagner, pp. 887-888.
14. Moving 50,000 Gallon Water Tank Without Dismantling, p. 888.

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15. Michigan City Builds Plant for Treating Lake Water, pp. 932-933.
16. Effects of Passing River Water Through Chain of Lakes. By R. A. Thuma, pp. 934-936.
17. p. Current Practices in Taste and Odor Control. By F. E. Stuart, pp. 940-943.

G *Water Works and Sewerage*
9 *August*
1. p. Water Works Finances—Past, Present and Future. By C. H. Capen, Jr., pp. 269-273.
2. Battery Meters—Their Installation and Performance. By C. M. McCord, pp. 287-288.
3. p. The Cycles That Cause the Present Drought. By H. P. Gillette, pp. 289-293.

J *American City*
9 *August*
1. p. Record of Underground Structures of a Water System. By E. A. Munyan, pp. 57-59.
2. Water Rates and Service Charges. (12 cities), pp. 85, 87, 89.

L *Civil Engineering*
9 *August*
1. Earthquake Effects on Elevated Water Tanks. By A. C. Ruge, pp. 455-459.

M *Canadian Engineer*
9 *July 23*
1. p. Tastes and Odors in Municipal Water Supply. By M. W. Cowles, pp. 16-17.

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2. p. Applying Cement Mortar Lining to Existing Water Mains. By T. H. Wiggin, pp. 7-10.
3. p. Selection of Pumping Equipment for Deep Wells. By R. E. Swanson, pp. 11-12.

P *Public Works*
9 *August*
1. New Water Purification Plant at Hammond, Ind. By L. Besozzi, pp. 13-16.
2. Studies in Water Consumption: North Atlantic States, p. 27.
3. p. Evaluation of Residual Chlorine, p. 28.
4. n. Municipal Water Softening Plants in Ohio, p. 28.
5. A Creosoted Timber Rock-Filled Dam, p. 18.

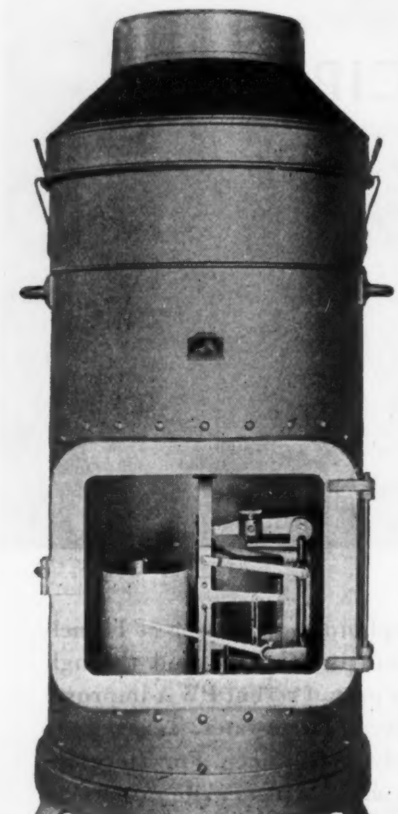
What's New?

A New Model Rain And Snow Gauge

A new model of the Fergusson weighing and recording rain and snow gauge is announced by Julien P. Friez & Sons, Inc., of Baltimore, Maryland. This gauge records rain, snow, hail and sleet with equal facility and in the same manner. Precipitation is delivered through a collector ring of known area to a receiver resting upon a spring balance. This weighing mechanism is extremely sensitive, for one hundredth of an inch of rainfall is sufficient to depress the balance and register on the record chart.

The record cylinder is revolved daily, or weekly by a jewelled clock movement, so that rainfall is shown as ordinates; time as abscissae. The unique linkage from the weighing mechanism to the pen arm allows an extremely open scale on a relatively narrow chart by reversing pen movement at several even increments of the gauge capacity. Capacities up to 12 inches of rainfall are offered with provisions for catchment of overflow 10 inches in excess of this amount.

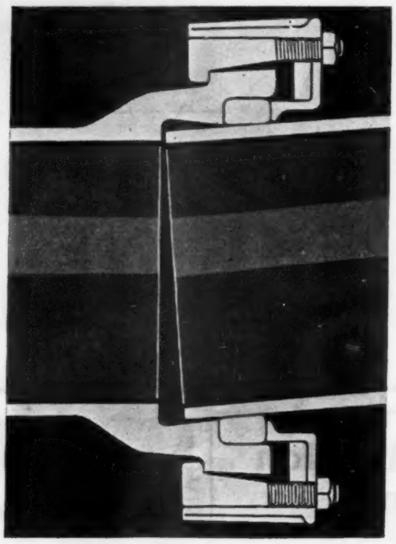
This model has a distinct application where heavy rainfall in short periods is experienced and where an accurate record with a minimum of attention is of special value. Other types of different capacities and applications are available. Descriptions on request.



Fergusson Recording Rain and Snow Gauge

Ovalseal Mechanical Pipe Joint

This is a new type mechanical joint which has been developed for use with cast iron pipe. It has a number of advantages, including the ability to lay adjoining lengths with a 6° deflection, thus simplifying the process of carrying a line through rocky sections, around curves, etc. The joint is very simple, permitting its use with unskilled labor. The gasket is made with semi-circular ends; for water installations this is usually of plain rubber.



The new R. D. Wood Mechanical Joint

It is not necessary to line up, center, or wedge into position the pipe ends at any joint. Tightening the bolts makes the gasket center the pipe perfectly. The only tool required is one wrench.

This new joint is made by R. D. Wood Co., 400 Chestnut St., Philadelphia, Pa., who will forward a very interesting and complete booklet on request.

The Le Tourneau 2-wheel derrick is fine for handling pipe.

Two-Wheel Tractor Derrick

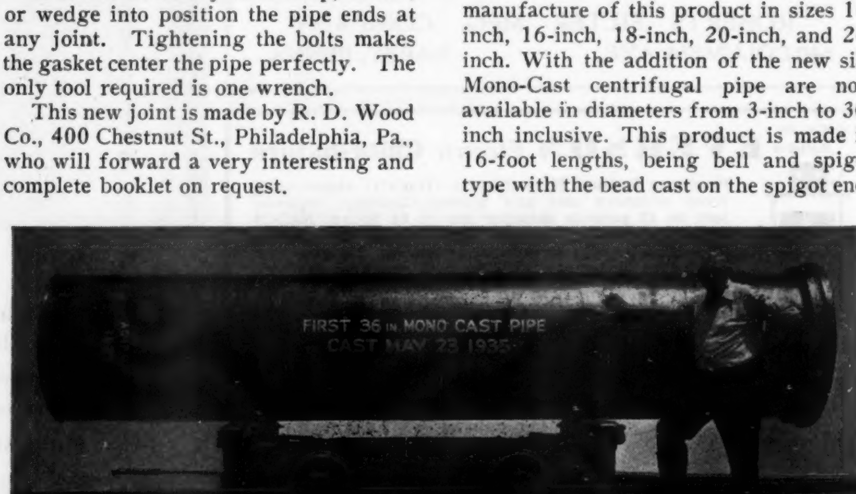
A new 2-wheel derrick for use with tractors is now being manufactured by R. G. LeTourneau, Inc., Peoria, Illinois, and Stockton, California. This derrick is very simply constructed, consisting of but three main parts; that is, boom, tongue and wheels. The boom comes in three lengths, 20, 30, and 40 feet.

This unit was designed particularly for use on construction jobs and in factory yards, and is suited for loading and unloading heavy equipment, laying pipe and culverts, placing poles and heavy timbers, lifting or moving heavy materials, etc. It can be connected to or disconnected from the tractor by simply dropping the draw bar pin.

ACIPCO 36-Inch Mono-Cast Centrifugal Pipe

The American Cast Iron Pipe Company, Birmingham, Alabama, has added 36-inch diameter pipe to the range of pipe sizes produced by the Mono-Cast centrifugal method. This announcement will be of interest to all users of large diameter pipe.

The manufacture of Mono-Cast centrifugal pipe on a commercial basis began in 1924; and for several years this pipe was made only in the smaller sizes. A new shop was built in 1931 for the manufacture of this product in sizes 14-inch, 16-inch, 18-inch, 20-inch, and 24-inch. With the addition of the new size Mono-Cast centrifugal pipe are now available in diameters from 3-inch to 36-inch inclusive. This product is made in 16-foot lengths, being bell and spigot type with the bead cast on the spigot end.



The Lettering on the Pipe Tells the Story

OK'd BY RESPONSIBLE BUYERS

Large Midwestern City
builds Armco Metal Cribwall
TO PERMIT STREET WIDENING

☆

Widening a city street made possible by speedy erection of Armco Metal Cribwall 160 feet long, with an average height of 8 feet

HEAVY traffic in the industrial district of a large midwestern city, made it necessary to widen the street. However, the street grade was higher than adjacent property, which in turn made filling necessary.

Protecting the adjacent property against encroachment of the fill, required a retaining wall at one point. After considering various types of walls, an Armco Metal Cribwall was selected as best meeting the requirements of Speed and Economy. Excavation was started on a Monday morning. By late Wednesday afternoon the wall was built, backfilled, and *ready for service.*

Armco Metal Cribbing units are light in weight and they are bolted together to form a strong, durable wall. Furthermore, should changing conditions require it, this type of wall can readily be extended, raised, or removed and used elsewhere.

Ask to see the Armco Cribbing Design Manual which the Armco man will be glad to discuss with you in terms of your retaining wall problems.

ARMCO CULVERT MFRS. ASSOCIATION
★ Middletown, Ohio ★

ARMCO
METAL CRIBBING
For unstable slopes

ARMCO

☐ Please send me your latest free catalog on Armco Metal Cribbing.
☐ I am interested in a wall about ...... ft. long by ...... ft. high.

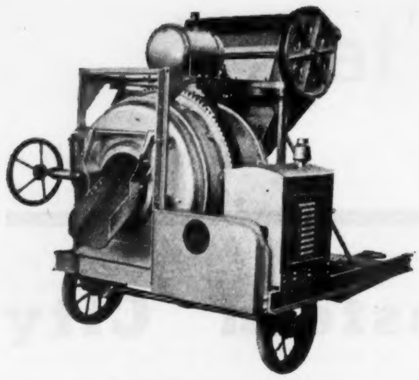
Name..

Street..

City..

I am ☐ Engineer ☐ Contractor ☐ Student PW-9

Needed Equipment for Public Works



New Ransome Mixer

Ransome's New 7-S And 10-S Mixers

Among the recent developments of Ransome Concrete Machinery Company, Dunellen, New Jersey, are the two-wheel, trailer type, end discharge concrete mixers in the 7-S and 10-S sizes.

These trailer type mixers are of lightweight but heavy-duty construction and are arranged on shock-absorbing springs with steel or rubber tired truck wheels equipped with roller bearings. Mixers are compact and well-balanced for towing and easy maneuvering on job, permitting mixers to be located in limited spaces.

Other features and refinements include positive water control with non-by-passing water valve; all steel drum with drum shell and mixing blades of high carbon wear resisting steel.

New Universal Sweeper-Blower

To meet the requirements of those state highway departments which now demand, on bituminous surface treatment contracts as well as on retread paving, that the road surface be cleaned by air as well as swept, The Frank G. Hough Company, 919 North Michigan Avenue, Chicago, have recently placed on the market their new Universal Sweeper-Blower. This machine, embodying the same general principles as their Universal Road Sweeper, is a combination machine which *both* sweeps and blows at the same operation.

Paving Tools

Here are some of the tools needed in bituminous highway construction and maintenance. Specially made for hard work by Littleford Bros., Cincinnati, O.

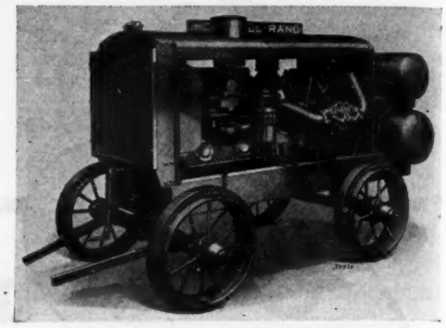
Ford Truck Mounting For P&H Crane

A new combination of speed and low cost mobility has been achieved by the Harnischfeger Corporation of Milwaukee in harmonizing the design of the new P&H Bantam Weight Excavator with the Ford V-8 truck chassis.

The upper structure, complete with sub-base and 25-foot boom, weighs only about 11,000 lbs., requiring only the addition of Twin-Flex third axle, equalizing springs and reinforced frame on the standard Ford chassis of 157" wheelbase. This combination results in the lightest truck mounted unit in the industry.

The 25-foot crane boom is of light welded tube construction for maximum reach with minimum weight. Loads as high as 2¾ tons are safely handled in ordinary operations, and may be increased to 5 tons with the use of outriggers. With greatly simplified attachments, the crane is also easily converted for use as ⅜-yd. truck shovel, dragline or clamshell crane.

Stabilizers on all four rear wheels eliminate spring action when crane is in operation. Weight is evenly distributed for long distance travel by swinging the boom in forward position. The unit is designed to comply with practically all highway and bridge regulations. Travel speeds are safe up to 40 miles per hour.

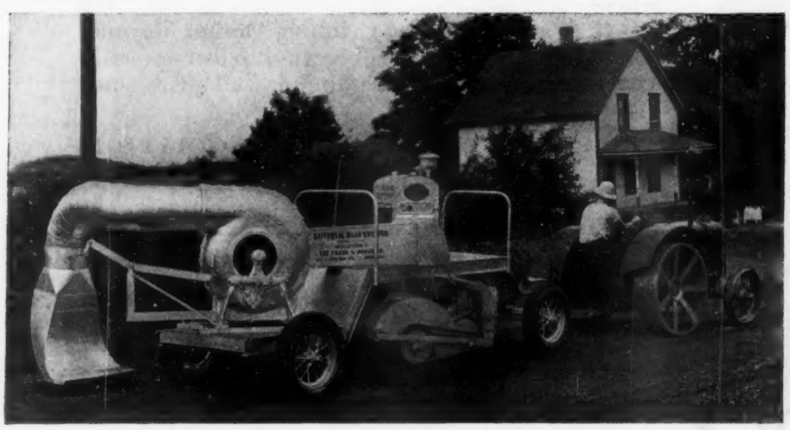


The Model 85, two-stage, air-cooled portable compressor is a recently announced development of Ingersoll-Rand Co., Phillipsburg, N. J.

3-Way Dump Trucks

The Commercial Shearing & Stamping Co., Youngstown, Ohio, which holds patents on a 3-way hydraulic dumping system for truck bodies, announces that its patents were recently held valid in a federal court decision.

The company's 3-way dump truck bodies are so equipped that they may dump either to the rear, or the right or left, as need requires. In filling along the sides of road work, this dump body has been especially valuable. In excavation work, the 3-way dump body has proved of service in expediting the work and thus effecting savings in time and labor.



Hough's Sweeper-Blower Makes Better Roads

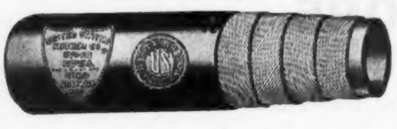
The Commercial 3-Way Dump Truck

For More and Better Public Works

Hose for Pneumatic And Drill Work

The Mechanical Goods Division of U. S. Rubber Products, Inc., has announced a new type of hose for pneumatic tool and air drill service—the U. S. Super Royal Cord. The outstanding feature of the new hose is its "tire-like" cords laid in tough rubber cushions isolated from adjacent plies to prevent rubbing or shearing. "U. S." claim that this hose can withstand any amount of pulsation, sudden expansion under pressure and constant flexing in use.

This new hose carcass makes U. S. Super Royal Cord so tough, it is said, that it shows remarkable resistance to external blows, bruises and abrasions. This durability is due not only to the internal structure but to the specially compounded brown rubber cover which will stand unusual abuse and will not peel when cut or gouged.



New U. S. Hose

For additional protection against the destructive action of hot oil in the air line, the tube of the U. S. Super Royal Cord is made of the finest oil resistant rubber.

High Speed Dirt Moving:

This new idea in dirt moving will handle 6 to 8-yard loads at speeds up to 16 miles an hour. Naturally, it is equipped with pneumatic, low pressure tires, both tractor and trailer. The drive wheels of the tractor carry a part of the load weight. Tires are 18x60-inch, and work well in soft and uneven ground.

The unit can turn very quickly, since the tractor undercuts the trailer. One man operates the entire unit, and braking, dumping, and winding are vacuum controlled from the dash. For further information on this A-C Speedster, write the Allis-Chalmers Tractor Division, Milwaukee, Wisc.

The Link-Belt K40 and K45

New Mack Styling on Traffic Type Trucks

Modernly-styled streamlined coupe cabs with integral all-metal roof construction feature the new and improved versions of Mack's CH and CJ Traffic Type trucks—the Mack cab-over-engine models.

A distinct innovation in truck design, the roll-out powerplant permits the withdrawal of the engine, clutch, transmission and radiator as a unit. The roll-out feature comprises a subframe mounting of the powerplant whereby it may be rolled out the front of the truck on its own rollers, so that the removal or replacement of the powerplant can be accomplished by one man in about an hour and a half.

Wheelbases are 6 inches less than on previous Traffic Type Macks for the same given platform length. This has been made possible by a further setting back of the front axle, the front axle to back-of-cab dimension being now 24 inches as compared with the previous dimension of 30 inches. Retaining their one-third, two-thirds gross weight distribution, these chassis now have, in addition, shorter turning radii and shorter overall length, due to shorter wheelbases.

Mechanical details of these trucks remain unchanged, the CH being powered by the Mack 4 x 5½, 108-horsepower engine; the CJ by the 4¼ x 5½, 118-horsepower engine.

Two New Shovel, Crane, Dragline Models

Announcement is made by Link-Belt Company, Chicago, of two new crawler-mounted shovels, cranes, draglines to be known as models K-40 and K-45 respectively. These new machines embody features which assure their attaining the maximum in ease of operation and maintenance, in performance and in service life.

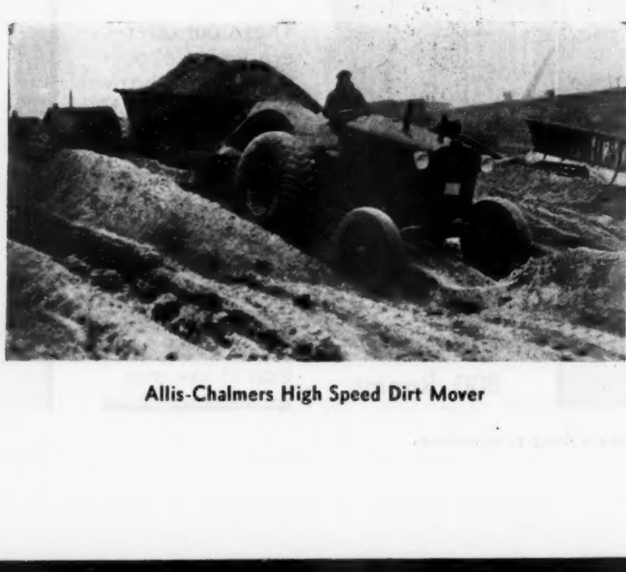
The Link-Belt line of crawler shovels, cranes, draglines are arranged for gasoline engine, Diesel engine, or electric motor drive. Each can be used as a shovel, a crane, a dragline, a trench hoe, etc., and may be furnished with any or all of the several attachments that are usually available only on smaller machines or machines of limited characteristics. This ease of convertibility reduces the owner's investment in equipment to a minimum without limiting the range of work possible.

An important feature is the ability to ship the complete machine on a flat car without dismantling, thus effecting a saving in both time and money in shipping the machine from one place or job to another.

As a shovel, K-40 and K-45 machines are standardly equipped with a 22 ft. shovel boom; a 16'-6" dipper stick; and an all-manganese steel, heavy-duty dipper, which is of 1¼ cu. yd. struck-measure capacity on the K-40, and 1½ cu. yd. struck-measure capacity on the K-45, or with correspondingly larger dipper for lighter service.

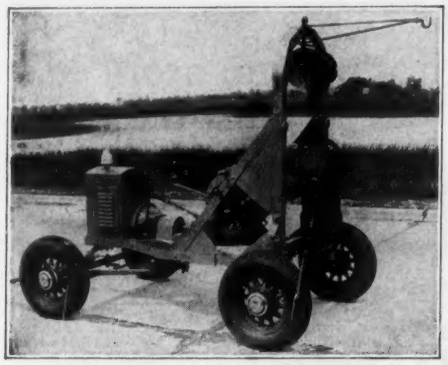
Worthington Pumps.—An excellent 8-page booklet on vertical sewage and drainage pumps, with installation data; a 4-page folder on air lift pumping systems; a 4-page folder on vertical centrifugal pumps; a 4-page folder on the No. 5 sump pump; an 8-page booklet, full of data, on deep-well turbine pumps. All these are obtainable without cost from Worthington Pump and Machinery Corp., Harrison, N. J.

Lawrence Pumps.—Bulletin 203 describes acid and chemical handling pumps, giving data on capacities and heads; bulletin 204 describes heavy duty multi-stage pumps for waterworks, industrial and other uses. Sent on request to Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.



Allis-Chalmers High Speed Dirt Mover

The New Streamlined Mack Truck



The Champion Power Sewer Cleaner

A Power Sewer Cleaner:

One of the often neglected jobs is that of cleaning sewers. With the old-type cleaners, where men had to go down in the manhole and bring out the dirt (to use a mild term), such neglect was perhaps justified or somewhat excusable. The new power sewer cleaner illustrated herewith brings the dirt right up to the surface where it may be loaded into trucks and hauled away. This machine has a lot of other features, too, that are worth investigating. It is claimed to work on sewers that are not strong enough for usual cleaning methods, and to do twice as much work as old-type hand operated machines. Cleaning sewers would make good employment for several men. It might be worked under one of the WPA projects we've heard about but haven't seen yet. A full description of this new piece of equipment, which is suitable for either large or small cities, can be obtained on request from the Champion Corporation, Hammond, Ind. We suggest it as being worth while investigating.

Rules and Tools:

This Catalog has 256 pages, all in type size easy to read, and carries in addition to full listings much valuable general information. It is conveniently divided into seven sections: Steel tapes, woven tapes, tape-rules, spring joint and boxwood rules, lumber rules, miscellaneous rules and precision tools. By means of its unique cover index and edge markers, one can instantly turn to any one of the seven sections. Complete alphabetical and numerical indexes are also included. Copy of this Catalog No. 12 will be sent on request. Address The Lufkin Rule Co., at Saginaw, Michigan, 106 Lafayette St., New York City, or Windsor, Ontario.

U. S. Joint Pipe:

A small booklet gives all dimensions and weights in accordance with Federal Specification WW-P-421, of the new U. S. joint pipe and fittings. This is a mechanical type joint employing a gasket.

Winter Concrete Work:

An 8-page illustrated folder issued by the Portland Cement Association; lots of interesting pictures. Sent on request to PCA, 33 West Grand Ave., Chicago, Ill.

News of Engineers and Engineering Associations

Joint Sewage Works Meeting:

A joint meeting of the New England and New York State Sewage Works Associations will be held at the Hotel Van Curler, Schenectady, N. Y., on October 4 and 5, 1935. For the technical sessions an interesting and varied series of papers has been arranged. Displays of sewage works equipment will be presented by a large number of manufacturers and will be available for inspection throughout the meeting. On Saturday morning, the famous sunrise breakfast of the New York State Sewage Works Association with round table discussion, this time for both associations, will be followed by an inspection of the Schenectady and Canajoharie treatment plants. An unusual feature of the meeting is a tour of the General Electric House of Magic for members and their guests, which will open the meeting on Friday morning. In addition to the technical sessions, entertainment features will provide a well-rounded program.

The ladies are cordially invited to attend this meeting and a committee is planning an enjoyable series of social events for their entertainment during the technical sessions.

New England Water Works Association:

The 54th annual convention of the New England Water Works Association will be held at the Providence-Biltmore Hotel, Providence, R. I., September 17 to 20. In addition to the usual excellent papers on water works subjects, there will be an exhibit of water works equipment and materials. Frank J. Gifford, 613 Statler Bldg., Boston, Mass., is secretary.

American Road Builders' Association:

Definite decision to hold another road show, this year at the Municipal Auditorium and Exhibition Hall, Cleveland, O., has been reached, following a recent meeting of the directors of the association. An "old-fashioned" road show is to be held, but so far details of the event have been unannounced. The date of the convention is set for January 20-24, 1936. Information can be obtained from Charles M. Upham, National Press Bldg., Washington, D. C.

News of Engineers:

I. M. Glace, for many years district engineer of the Pennsylvania State Department of Health, has opened offices, so we hear, at 22 South 22nd St., Harrisburg, Pa., and will specialize as consulting engineer in water supply, sewerage and sewage treatment, and similar sanitary engineering work.

Coleman Mark, formerly with the Pennsylvania State Department of Health, has, we understand, been placed on active duty in his reserve rank as Major, Sanitary Corps, and assigned to CCC work in the Third Corps Area. As pointed out in these columns previously, Major Mark will probably find plenty to keep him busy.

Applications for the position of Junior Engineer in chemical, civil, structural and concrete fields, will be received by the U. S. Civil Service Commission at major post offices or at Washington, until September 16. Salary $2,000 per year.

Bernard E. Gray, highway engineer of the Asphalt Institute, New York City, has been promoted to the grade of Lieut.-Colonel of Engineers, U. S. Army Reserve.

Harry A. Faber has recently been appointed assistant sanitary engineer of The Chlorine Institute, Inc., New York, N. Y., vice W. M. Bingley resigned. Mr. Faber is a graduate of Cornell University, 1930, and was formerly in the employ of Consolidated Water Co. of Utica, N. Y.

Charles W. Daniels has been appointed sales manager of the entire line of P & H contractors' equipment, industrial products, arc-welders, hoists, etc. He has recently been in charge of the Philadelphia office, where he is succeeded by L. M. Stout.

The Burns & McDonnell Engineering Co., Kansas City, Mo., and Cincinnati, O., have opened a permanent engineering office in the Home Savings Bank Bldg., Albany, N. Y. This eastern engineering office will be in charge of Hartwell J. Rosson, formerly in charge of the Cincinnati office. M. C. Bartlett will succeed Mr. Rosson at Cincinnati. This firm now has work in progress in the east at Yonkers and Auburn, N. Y.; Newport, R. I.; Cumberland, Md.; and New Castle, Pa.

The C. H. & E. Manufacturing Company of Milwaukee, Wisconsin has announced the appointment of the following companies as exclusive distributors of C. H. & E. Saw Rigs, Pumps, Hoists, and Mortar Mixers: The Albany Construction Equipment Company, 137 South Allen St., Albany, New York and Northeastern New York State; Brown and Sites Company, 30 Church Street, New York City in the Metropolitan New York area and the State of Connecticut; Paving Supply & Equipment Company, 10th & Girard Sts. N. E., Washington, D. C., in D. C., and Eastern Maryland.